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Royal College of Surgeons of England.

JACKSONIAN PRIZE.

CABLED ADVICE has been received that the subject of the Jacksonian Essay for 1947 is "The Surgery of the Lower Œsophagus and Cardiac End of the Stomach". Full details governing the conditions of the prize may be obtained from the Secretary of the Royal Australasian College of Surgeons, Spring Street, Melbourne, C.1.

Editorial Notices.

ALL articles submitted for publication in this journal must be typewritten and double or treble spacing should be used. Each article should conclude with a brief summary and statement of conclusions. Authors are requested to avoid the use of abbreviations and not to underline either words or phrases.

Authors are requested to submit two typescript copies of all articles.

References to articles and books should be carefully checked. In a reference the following information should be given without any abbreviation: initials of author, surname of author, full title of article, name of journal, volume, full date (month, day and year), number of the first page of the article. If a reference is made to an abstract of a paper, the name of the original journal, together with that of the journal in which the abstract has appeared, should be given, with full date in each instance.

When illustrations are required, good photographic prints on glossy gaslight paper should be submitted. Line drawings, charts, graphs and so forth should be drawn on thick white paper in indian ink. Authors who are not accustomed to prepare drawings of this kind, are invited to seek the advice of the Editor if they are in any doubt as to the correct procedure. Skiagrams can be reproduced satisfactorily only if good prints or negatives are available.

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THE AUSTRALIAN AND NEW ZEALAND JOURNAL OF SURGERY

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SURGERY IN JAPANESE PRISON CAMPS.[1]

By A. E. COATES,
Melbourne.

THE narrative below includes some of the author's experiences in prison camps: (*a*) in Burma, 1942, small camp hospitals (300 to 500 patients); (*b*) in Burma, 1943, jungle hospitals (1,800 patients); (*c*) in Siam, 1944-1945, at Nakompaton Base Hospital as chief medical officer and consulting surgeon (10,000 patients).

In the early days of life as a prisoner of war I was permitted to perform a number of operations on wounded from bombed ships in the local military hospital. After the Japanese prisoner-of-war guards took control, denial of these facilities was one of their first acts. From May, 1942, until the capitulation of Japan surgical operations on prisoners of war were performed under primitive conditions, and even facilities available at nearby civil hospitals, such as Tavoy in Burma, and Bangkok in Siam, were withheld.

On leaving Padang, Sumatra, to go to Burma, I was not permitted to take any instruments, but was told that we were going to a fully equipped hospital. This story became monotonous during the succeeding moves in our prisoner-of-war pilgrimage. This deliberate policy of the Japanese was in keeping with their other brutal and inhuman treatment of prisoners of war.

My first operation in Burma was a tracheotomy for laryngeal diphtheria. The next was for the cure of a strangulated inguinal hernia. These were done in the coolie lines at Mergui on two Australian prisoners of war.

At Tavoy in October, 1942, I was permitted to take patients with serious surgical conditions to the local civil hospital, but the Japanese medical officer in charge, Lieutenant Watanabe, insisted that after operation the patient should be transported over a rough road, five miles to the prisoner-of-war camp. This resulted in the death of two Australian patients, and henceforth I operated clandestinely in a hut in the camp.

An autoclave was made from a petrol drum and sterilization of materials and instruments was carried out in the usual way. At that time we had a few gowns and instruments and catgut, which had been brought from Singapore. The usual routine type of surgery was done—appendicectomy, hæmorrhoids, perforated ulcer of the stomach *et cetera*. One case was of interest.

A Dutchman, a prisoner of war, aged forty-two years, had suffered from dysentery for six months. With a past history of both amœbic and bacillary dysentery in the Netherlands East Indies, he was then having sixty motions a day, passing blood and pus, and he looked very ill. His doctor urged me to do something, as all medical measures had failed. I performed an ileostomy under a spinal anæsthetic. After two

[1] Accepted for publication on February 15, 1946.

or three days of storm he recovered, and later a cut-down Dutch water-bottle was fitted to the ileostomy. He continued to improve, without further treatment, having no emetine, and later acted as one of my medical orderlies, doing the heaviest work. I closed the ileostomy two years later at Nakompaton prisoner-of-war camp, doing a side-to-side anastomosis of the ileum.

I observed at the first operation thickening and œdema of the left colon, descending and sigmoid. The ileostomy was of the double-barrelled type and the proximal opening being placed below the distal opening, both were brought through the transrectal incision. The stool became firmer as months went by, until it was of a putty-like consistency. The excoriated abdominal wall quickly hardened up and gave no trouble. The dramatic success of this case was pointed out one year later at Nakompaton Base Hospital and the medical officers there showed a mild interest. However, after a few months the physicians who had been struggling with such chronic cases both with and without emetine, requested that the operation of ileostomy be tried in selected cases.

The results of the operations will be the subject of a paper by Lieutenant-Colonel Dunlop.

Major W. E. Fisher, the consulting physician at Nakompaton, asked me to perform the operation in a small number of cases, as also did Lieutenant-Colonel Larsen (Dutch), but if medical relief had not arrived late in August, 1945, many more patients would have been submitted to ileostomy. Since amœbic dysentery was confined exclusively to the large bowel—in all the autopsies we saw both in the jungle and at Nakompaton—there was little danger of amœbiasis of the abdominal wall following ileostomy. Emetine was not a necessary safeguard and the operation could be undertaken with certainty of relief from the painful tenesmus, the gas pains, the distension and the averting of the fatal perforation which we saw all too frequently in the jungle. The rest provided to the colon allowed healing of ulcers and arrest of hæmorrhage. Regular proctoscopic examination of patients operated upon showed gradual change from the thick, red, œdematous, often ulcerated mucosa to a pink, healthy appearance of the normal rectum.

Sigmoidoscopy was impossible by the usual equipment. No electric bulbs or batteries were allowed by the Japanese. Proctoscopes were fashioned of tin and an instrument three inches long, one inch in diameter with slightly inbent edges, transmitted sunlight reflected from a mirror for several inches up the rectum. The patient was placed in the knee-elbow position. The three rectal valves could readily be seen, and ulcers which frequently eroded them. Strictures which were quite common in healing stages were dilated with bamboo graduated dilators. Smears were taken from ulcers which in many were small and stellate, or transverse and covered with lymph. A positive finding was often obtained from such a smear when the result of repeated stool examination had been negative. A regular proctoscopic clinic was conducted by myself at the 55 Kilometre Camp, Burma, and later, at Nakompaton, the work was done by the staff of the dysentery block, that is, the physicians at Nakompaton.

One such patient, an Australian sergeant, developed a stricture at 55 Kilometre Camp, and obstruction was so great that emergency colostomy had to be performed in September, 1943. Later, at Nakompaton, after repeated attempts to deal with the stricture internally, I did a Kraske operation and later closed the colostomy. The patient returned to Australia in good health.

Amœbic dysentery sometimes produced masses in the abdomen or rectum. A mass in the right iliac fossa was a dangerous condition, and many patients in 1943 presented a mass in the right iliac fossa shortly before death. Distension would follow and then perforation. I opened the abdomen of one patient with a perforation in the jungle, at the insistence of the patient himself, but realized that nothing could be done but drainage of the abdomen. He died. Extensive sloughing and the passage of casts of the colon occurred in many cases. Severe and fatal hæmorrhage occasionally ended the patient's life.

One of my medical orderlies in Burma jungle was nursing dysentery patients. He did not report ill, but his mate told me that he was passing frequent small motions of blood and mucus. He did not look very ill. I sent him to the base hospital at Thanbyuzayat. He died shortly after arrival of massive hæmorrhage from the bowel. At that time no emetine was available.

Colostomy is a dangerous procedure in amœbiasis.

In Malaya in 1941 I had a patient who was suspected of amœbic dysentery. Many stool tests gave negative results. He had a mass in the middle and upper parts of the rectum. Sigmoidoscopic examination revealed a large red mass, somewhat resembling a carcinoma. Snippings were taken and the pathologist reported that it might be carcinoma. He could not be sure. I performed left iliac colostomy. A few days later the skin became red and œdematous and brown in patches, and developed the appearance sometimes seen in gangrene of the abdominal wall. I realized he had abdominal amœbiasis. Emetine was given at once, which cleared up the skin condition as well as the rectal mass.

I quote this case again (see *The Medical Journal of Australia*, January 17, 1942, page 63) to stress: (*a*) the futility of relying on any number of stool tests. Twenty are better than three, but still not certain. (*b*) The fact that the colon should not be opened in suspected amœbic infection; hence ileostomy should be performed if any surgery is indicated.

In one case, that of an Australian, a suspected carcinoma of the right colon (ascending) was removed after three months of ileostomy for intestinal obstruction. This mass proved to be a granuloma. Amœbæ were found in the bowel wall at least one-third of an inch from the mucosa, that is, under the thick, fibrosed peritoneum.

Emetine is a specific for amœbic dysentery. I cannot imagine anything more dramatic. I have had two attacks, one early in 1942 and one later in 1944. Fortunately on both occasions emetine was available, and after the first or second injection relief was obtained. I shall not discuss the drug treatment and the other medical aspects of this disease, as it is the province of the physicians, but surgeons must beware that: (i) A suspected appendicitis is not amœbic typhlitis and appendicitis. (ii) A mass in the right iliac fossa may be an amœbic granuloma. Obstruction may occur; if the mass is opened death will follow. (iii) Masses elsewhere, even in the rectum, may be amœbic and not carcinomatous. (iv) Vague colonic trouble, irritable colon, chronic colitis, stricture, may be of amœbic origin, despite all negative stool findings. (v) Dyspepsias of vague nature, not otherwise explained, are sometimes of amœbic origin.

In the dysentery block at Nakompaton there were 1,500 patients, of whom 1,346 were proved to have amœbic infections by stool or smear tests. Appendicitis was more common in that block than in all the others together (that is, 6,500 other men). The first two patients who developed the disease in the early days of 1944 at Nakompaton had nothing much to show but a quiet process in the abdomen. In both cases perforation occurred and the patients died. The post-mortem examinations showed that there was no inflammation in the ordinary sense—no lymph, no adhesion. In other words, the process was one of necrosis, in a debilitated subject, similar to what we had seen in cases of ulcer of the leg in the jungle. I therefore instructed that in all suspected cases of appendicitis from the dysentery block operation should be performed. The results are shown in a paper by Major S. Kranz. Probably some patients were operated upon unnecessarily, but we could not take the risk of leaving them to suffer from perforation. The general resistance of the men was so poor and the operation relatively easy and free from danger that we considered the policy the safer one in the end. An instructive case is the following.

A Dutchman, aged thirty-eight years, had been in the dysentery block for fifteen months. He had typical blood-stained, small, frequent stools. He was a very weak and anæmic man with an earthy appearance. Many stool tests had failed to reveal

amœbæ, either vegetative or cystic. He had a vague mass in the left iliac fossa, not unlike that found in many cases of chronic amœbiasis. Lieutenant-Colonel Larsen asked me to operate. Under a spinal anæsthetic I exposed a swollen sigmoid colon, in which was a vague mass somewhat diffuse. Clamping the bowel off low down at the level of the pelvic floor, I dissected away the mesocolon and brought up the whole sigmoid and iliac colon, which I exteriorized at the upper corner of the left oblique iliac incision. I then closed the rectum and oversewed the stump after cauterizing with the soldering iron. Then I placed a clamp on the descending colon at the point of emergence from the abdomen and cut off the bowel below. A temporary transverse colostomy was then done and the abdomen was closed. Inspection of the interior of the removed bowel revealed multiple polyposis with ulceration. This was regarded then as the cause of his trouble. Microscopic examinations of the cut bowel wall (slices cut with a razor and stained with methylene blue) showed many amœbæ deeply buried in the thick subperitoneal tissue. He was then given a course of emetine (five grains—all we could spare at that stage). He quickly put on weight and gained strength. Further repair of the colon is yet to be done.

Hepatitis was common in amœbic cases. The physicians treated the patients with emetine injections when available. Eight came to surgery with abscess of the liver. I operated upon five such patients. The first two were seen as they arrived from the jungle in early 1944. There was no emetine; both had enormous collections of pus in the liver. One died of perforation of the colon after some weeks of recovery from the drainage of the abscess; the other continued to drain pints of pus from the liver and just faded away. Three other patients did very well following drainage. Aspiration was done on the operating table and if pus was obtained (that is, true yellowish-grey pus, not simply "anchovy sauce"), the left ninth rib arch was infiltrated with "Novocain" and the parietal muscles were sutured to the diaphragm and the two were divided and a drain inserted. Lieutenant-Colonel Dunlop had one patient with an abscess in the left lobe of the liver. Considering the large number of untreated amœbic patients (1,346), the incidence of liver abscesses was low. In one of the three successful cases the patient had had an abscess drained by the anterior route up country and he had to have posterior drainage performed as well as thoracotomy for an associated empyema. This man had altogether nine operations, ending up with a thoracoplasty of the Schede type. He is a healthy Australian, home today. One patient at Nakompaton died of brain abscess, an amœbic abscess of the vermis of the cerebellum.

The subject of amœbiasis has been dealt with at some length because it is not simply of historical interest. Among the returned prisoners of war the condition, which has been for the majority of sufferers untreated, must be regarded only as quiescent, and it may therefore present itself to surgeons in many forms of disguise.

Of less immediate interest is the subject of ulcer of the leg, so-called "tropical ulcer". By the middle of 1943 most prisoner-of-war doctors were quite familiar with tropical ulcer. We had seen it in Malaya. I had seen scores of cases among the evacuees in Sumatra. The circular ulcer, with a sloughing base on the fascia, usually confined to the leg, its indolent edge with the tendency to undermine, was treated according to standard methods. Light curettage, removal of sloughs, dusting with iodoform powder and sealing up for several days usually resulted in cure. Foments and sulphanilamide powder, where available, were used successfully by some medical officers. Adequate rest was essential.

By June, 1943, conditions among prisoners of war on the Burma-Siam railway were deplorable. Sick and injured were kept in their working camps for months, and when a sufficient number were collected or the camp moved on, the abandoned huts would be used to house the patients. Such a so-called hospital was the 55 Kilometre Camp at Kohn Kuhn, Burma. There were collected the majority of the casualties of the railway in Burma in the

second half of 1943, that is, 1,800 patients, of whom 500 suffered from ulcer of the leg. There was an odd ulcer of the hand, back, forearm or thigh, but the vast majority had one or more ulcers on the lower extremity, usually in the distal half. The malleolar area and the front of the shin, obviously more exposed to trauma, were common sites. Malaria, relapsing and inadequately treated, owing to shortage of quinine, was a debilitating background. Pellagra in lesser or greater degree was almost universal in the camp. The ulcer was usually caused by a bamboo or stone scratch. Local necrosis occurred, followed by breaking down of skin and showing a sloughing base and undermined edges. The process spread, partly peripherally and partly by erosion of fascia, periosteum and blood vessel, and by an extension into muscle and along tendon sheaths, gradual destruction of the limb occurred. The discharge was thin and watery and foul smelling. In some cases there was a black slough and almost no discharge. Diphtheria was not evident in that camp, although two patients had been noted among the prisoners of war in 1942.

The ulcers varied in size from that of a dollar piece to the area of one's outstretched hand. Rarely did they completely encircle the leg. The spread was to the deeper tissues more than peripherally, in contrast to some tropical ulcers described in the textbooks. Rapid extension of the ulcer invariably occurred when the patient had: (*a*) a recurrence of malaria; (*b*) an exacerbation of diarrhœa (pellagra); (*c*) the onset of œdema. The two last mentioned were the result of food deficiency.

In this series at 55 Kilometre Camp the ulcers had been neglected (by the Japanese). Men had been forced to work when the ulcer was amenable to treatment. Exhaustion, malnutrition (deficiency of protein and fat) and neglected malaria removed all trace of resistance. Hence the ulcer was a necrotic effect. Death of tissue occurred, there was no healing from within. As for local treatment, there was no iodoform or sulphanilamide. Boracic was tried, and permanganate of potash and biniodide of mercury (of which few tablets were available), but all to no effect. Hot rice poultices were used as a routine to try to promote local inflammation. Bits of clothing, mosquito nets *et cetera* were torn up and used repeatedly as dressings. Pus formed in some cases, and how welcome it was! The unbearable pain of ischæmia and necrosis (no morphine) was replaced by a more kindly and tolerable pain of inflammation. The "laudable pus", so well known to our forefathers, indicated that the battle was on, and the prognosis improved accordingly. Quiet separation of a sequestrum, or slow invasion of a tendon sheath then occurred. The mechanical removal of the dead tissue was undertaken at the appropriate time.

There were 60 cases in which a tendon such as *tendo Achillis,* the tibial tendons or peroneal tendons became invaded by the ulcerous process; swelling of the tendon above and below, with intense pain, occurred. The removal of the affected tendons and muscle through a long fascial splitting incision resulted in recovery and retention of a useful limb in 60 cases. Surprisingly little disability followed removal of such tendons. On leaving 55 Kilometre Camp all such patients were classified as suffering from permanent disabilities, but to my surprise many of them recovered almost full function of the limb; for example, two medical orderlies who had the *tendo Achillis* excised walked and worked normally at Nakompaton a year later. The occasional spread of the disease along a strap-like muscle reminded one of anaerobic infection. No evidence of gas was ever detected in the muscle, but a brick-red colour was sometimes observed in muscles of an amputated leg. The fœtid odour was not unlike that noted in gas infections, but in the absence of microscopic and cultural tests no definite opinion of the organism causing the infection can be given. It appeared that a symbiotic process was

at work, but the fundamental fact of non-resistance was the only one to be vouched for. Hæmorrhage occurring in an ulcer was universally of evil omen. Erosion of arteries such as the posterior tibial indicated a severe, deeply spreading process, and in such cases the patients were rarely saved, even by amputation. Similarly, a destruction of a joint indicated a fatal prognosis.

A medical orderly in the ulcer ward scratched the back of his hand. A rapidly spreading phlegmon developed within thirty-six hours. Conservative measures failed and the arm had to be amputated. The same gangrenous process was seen in the muscles of the hand and forearm. Fortunately he survived.

It had been suggested that beriberi played a part in the production of these ulcers. I investigated this problem at the time. Reflexes were always present, there was no anæsthesia or paralysis, pain was an outstanding feature, and in no case, to my knowledge, did a patient die of sudden heart failure. I consider that beriberi was not an important underlying factor. The real deficiency was of protein and fat. Famine œdema and pellagra were invariably present in the bad ulcer cases. A sore tongue, angular stomatitis, anorexia, dysphagia, diarrhœa and mental apathy were in keeping with the autopsy findings—for example, shrunken organs, heart, liver, spleen, kidneys, diaphanous bowel, thin-walled stomach and convolutional atrophy of the brain. It appeared that all stores of fat in the body had been exhausted. Possibly even the brain had lost some of its valuable myelin material. The latter fact could not be decided precisely. The whole brain was thinner and there was secondary hydrocephalus in some cases. The protein of the body had been drawn upon to the point of breakdown of the efficiency of the organ, and so the poor fellows simply faded away.

This is not the place to describe the struggles with our custodians for more food and drugs. By devious means meat was obtained in moderate quantities in the later months in that camp, and the effects of gradually increasing doses of this, the best medicine for such conditions, was soon apparent. Sloughing ulcers began to suppurate. Inflammation, a normal reaction of the body to injury and infection, began to appear, and the surgical removal of dying limbs ceased. Amputation of the lower limbs was performed in 120 cases. I personally did 114, all but 25 above the knee. The leg amputations were done for ulcers destroying the foot and ankle. The thigh amputation was necessary for ulcers above the middle of the leg. The site of amputation in the leg was selected with a view to preserving as much of the limb as possible. Lateral flaps gave better drainage, but good results were obtained with anterior and posterior short flaps. Above the knee the skin was usually so thin that we found the circular amputation had to be done just above the lower third. Supracondylar amputations were found to be difficult to cover. Flaps were loosely sutured; now and then accurate apposition and first intention healing occurred. Drainage by bits of rag was the best we could provide. Ligature of the leg arteries was done with cotton, but owing to the filthy conditions we were afraid to use this substance for the femoral artery, for which locally made catgut was employed.

Secondary hæmorrhage occurred in about 10% of cases. Ligation in continuity of the common femoral artery in Scarpa's triangle was then done. One patient had repeated secondary hæmorrhage and eventually the common iliac artery was tied. He survived for many months and then died of inanition. I explored a few stumps of patients who had died weeks after operation and who had had secondary hæmorrhage. The outstanding feature was the absence of a clot to the next branch above the ligature. Non-healing of stumps was associated with non-formation of normal clot. The most elementary processes of repair were in abeyance in these cases. Lateral flaps

and antero-posterior suture were found helpful for easier drainage and better healing in thigh amputations. The sciatic nerve was drawn down a little, ligated and allowed to retract. Bone was simply cut straight through with a tenon saw. Muscles were never sutured.

The anæsthetic agent used in that camp was cocaine given by the spinal route. Among odds and ends acquired during my conducted tour was a bottle of cocaine tablets. Experimenting with this drug, we found that the smallest amount which could give anæsthesia to the groin was 1·5 cubic centimetres of a 2% solution. This was made up in distilled water, prepared by my Dutch chemist, Van Boxtel. Motor power was often not affected, so that the patient could cooperate with the surgeon by adjusting the position of his leg. This anæsthesia was employed in 200 cases without untoward effects. Locally administered cocaine, a 0·5% solution, was used for ligature of the common femoral artery when done as a separate operation. All operations were done in a small bamboo annexe to the ulcer ward. The Japanese would not allow us to build an operating theatre, but designed and had constructed an elaborate mortuary.

Alcohol, made in the camp from rice, was used as an antiseptic. The surgeon operated with naked hands, after scrubbing in several changes of warm water and immersion in alcohol. The effectiveness of this procedure is shown by the fact that none of the wounds for ligation of the femoral artery became infected. Later, at Nakompaton, the same method was adopted and less than 2% of herniotomy wounds became infected; but, as will be demonstrated, when the same method was used for internal abdominal surgery, adhesion formation was much more marked than is usual with a gloved-hand technique. Perspiration in the humid tropical climate was constant, and the no-glove technique is only to be advised *faute de mieux*.

Abdominal operations were undertaken at the 55 Kilometre Camp only when extremely urgent. The only patient with acute appendicitis was treated conservatively and an abscess was drained. Two patients with intestinal obstruction were operated upon. In a few cases prolapsed piles were dealt with surgically.

The instruments were few—three or four artery forceps, a scalpel, and sharpened table knives for amputation, bent forks as retractors, a soldering iron and a tenon saw.

The manufacture of catgut was as follows. Ox intestine was cleaned. At first an attempt was made to prepare the submucous coat; it proved too fragile, so the peritoneum was used, as sausage casings. The gut was turned inside-out, all layers were peeled off and only the casing of peritoneum was left. This was cut into appropriate strips, twisted and dried in the sun. It was then wound on a stick and placed in a tin under the rice-cooking fireplace, after the fires had been drawn. The temperature there was sufficient to boil saturated salt water. This process was twice repeated and then the gut was placed in alcohol. It was impossible to defat or polish the gut. It lasted about ten days in a wound.

Later, at Nakompaton, the process was improved, sterilizing being done by suspension in a tin placed in boiling salt water for one hour. No case of infection or tetanus due to the gut occurred. Many scores of abdominal incisions were closed with it, and on the whole it proved quite effective. For hernia repair it was too thick and tended to give a little discharge. Interrupted cotton sutures were used exclusively for that work.

The manufacture of catgut and alcohol, the extraction of 150 grains of emetine from a small quantity of liquid ipecacuanha, the preparation of spinal anæsthetic agents from cocaine under the primitive conditions of the

55 Kilometre Camp were due to the team work and enthusiasm of the staff acting on instructions, and especially to the splendid efforts of my Dutch chemist, Van Boxtel.

All the seriously sick and those with permanent disabilities were removed to Siam at the end of 1943. At Tamarkan they were held at a staging hospital for three months under the command of Major Allan Hobbs, A.A.M.C. During a visit to the large Siam sick depot at Chungki I saw for the first time blood transfusion by the defibrinated method being done by Captain Marcowitz, Royal Army Medical Corps, and a team of lay officers and men. On my return to Tamarkan the method was at once adopted. Van Boxtel and a team of laymen were trained in the technique, and henceforth until the end of the war transfusion by this method became a regular practice. A fine metal catheter was filed down to make a donor's needle; a Record syringe needle was used for the recipient. The blood was received into a jug made of a beaten aluminium mess tin, stirred for ten minutes with a bamboo switch to which the fibrin became adherent; then the defibrinated blood was given to the recipient. A small stab was made in the skin over the recipient's cubital or saphenous vein to permit the more easy entry of the needle. The team became expert, and rarely was it necessary to cut down on a vein. Meticulous mechanical cleansing of the needles, tubing (bits of stethoscope rubber), and vessels was insisted on before sterilization by boiling. Reactions were few. No citrate was available, hence this method proved the only practicable one. Major Reid, Royal Army Medical Corps, first suggested the method at Chungki. The organization of the teams, and the working out of detail were due to Captain Marcowitz. Hundreds of lives were saved by this valuable addition to our therapeutic armamentarium. At Nakompaton alone 1,500 transfusions were given.

In March, 1944, the newly constructed hospital camp at Nakompaton was open to receive all the chronically sick and permanently disabled men from the railway. Ten thousand prisoner-of-war patients passed through this hospital in the following eighteen months. By May, 1944, there were 8,000 prisoners of war in the hospital, 1,000 belonging to the working party and 7,000 patients British, Dutch, Australian and American. A full description of the hospital and the conditions there has been given elsewhere.

The surgical work was organized as follows:

Chief Medical Officer and Consulting Surgeon: The author.
Senior Medical Officer (Surgical Block): Lieutenant-Colonel Dunlop, A.A.M.C.
Senior Visiting Surgeon: Major S. Kranz, A.A.M.C.
Officer Commanding the Acute Surgical Ward: Captain J. Maconochie, R.A.M.C.
Dutch Surgeons: Captain Winckel and Lieutenant Killian.

The surgical block contained over 1,000 patients in the early stages. As patients recovered they were transferred to either the permanent disability block or to the convalescent block. For example, 170 patients who had been subjected to amputation were at first in the surgical block, but gradually, as they recovered, they became the nucleus of the permanent disability block and engaged in work such as cigarette making, bag making, artificial limb making *et cetera*.

The wards were bamboo huts provided with wooden platforms on each side of a central passage. The patients lay on the platforms. No beds were available until 1945, when the Japanese ordered all improvised beds, of which there were a few possessed by officers, to be put into the acute surgical ward. Bugs were a pest, and after a lot of persuasion the Japanese allowed the wooden floors to be pulled up every week for cleaning. In 1944 the main

surgical work was the dressing and grafting of old ulcers, sequestrectomy and physiotherapy. Lieutenant-Colonel Dunlop took charge of the last-mentioned work, and a team of recovered patients made apparatus such as splints, rowing machines, stationary bicycles, artificial limbs, stretchers, braces, belts and containers.

The bombing by the Allies of a neighbouring prisoner-of-war camp provided 100 wounded in September, 1944. Among them were several with compound fractures of joints. Two patients suffering from destruction of the shoulder joint were treated by removal of the comminuted head of the humerus.

In one case of bomb wound at the hip joint traction was used. Drainage was imperfect, the patient became very ill, and despite repeated blood transfusion did not do well. Amputation of the thigh was done under a spinal anæsthesia and the stump was split laterally, the upper half of the femur was removed subperiosteally, and the broken head of the femur was extirpated. He recovered and later had a firm stump ten inches long. An extraperitoneal abscess was drained and dead bone was removed.

The operating theatre was a wooden building, the end of a series of rooms forming a clinic and offices. It had a concrete floor, fly-wire windows, and latterly a skylight in the roof. Wooden operating tables, head rests and other equipment were made by the staff. Gowns were supplied by the Japanese. Caps and masks were worn.

Towels were borrowed from patients. Odd instruments brought in by arriving medical officers were pooled. A reasonable kit of artery forceps, knives and home-made retractors, darning needles, formed the basis of our instrument stock. Carpenters' saws, a single trephine, a bone-cutting forceps, soldering irons, locally made silver clips, a suction pump made of milk tins provided

all that was essential for a head or spine casualty. An autoclave was built of tins, and gowns were sterilized with steam. Instruments were boiled.

In July, 1944, Red Cross stores arrived, including a few rubber gloves, rubber tubing and dressings, drugs such as sulphanilamide, "Mepacrine", sulphaguanidine, and a little emetine. An operating set so supplied was retained by the Japanese. The surgical stocks ran out and we were forced to return to the primitive methods until the Japanese capitulation.

An alcohol factory distilled three pints of 90% alcohol from rice each day. A Cambridge scientist, Dr. Chapman, a prisoner-of-war private in the Malay Volunteers, produced the alcohol from rice refuse.

Dr. Kostermans, a Dutch botanist, made a number of useful botanical products, stains, indicators, paper and ink.

A pathology laboratory, under Major Marsden, Royal Army Medical Corps, rendered a valuable service. Blood urea estimation, section cutting, bacteriological and biochemical work became a routine. Acid recovered from peptic ulcer patients was used in the dispensary as well as in the workshop. Proctoscopes made of tin were used in the rectal clinic; 1,500 dysentery patients provided plenty of material. Piles were injected with carbolic acid and peanut oil; in some cases they were removed surgically. Appendicitis was common among dysentery patients. The problem has been discussed above and will be more fully dealt with in papers by Major Kranz.

Hernia repair was insisted upon by the Japanese. Only after experimenting on a few clean cases would we agree to operate on these patients. Despite the difficulties—no gloves, locally made catgut, cotton *et cetera*—the results were so satisfactory that patients themselves asked to be operated on. This subject will be dealt with in some detail by other surgeons, but it is appropriate to point out that my colleagues, who did most of the operating, collaborated so well that we standardized the procedure and followed the technique in the minutest detail. Not more than two, or at the most three, were engaged in an operation—surgeon and/or assistant and one scrubbed-up orderly. Soap and water and spirit cleansed the hands. Clean cuts, minimal blunt dissection, few ligatures, careful protection of the skin edges, the use of a wire automatic retractor, careful anatomical identification were the rigid rules.

Simple removal of the sac, transfixion and ligature with cotton were done in appropriate cases. The modified Willys-Andrews technique, converting a vertical funnel into a narrow oblique canal, was the procedure in larger herniæ of the inguinal type.

As many of the patients were middle-aged Australians and Dutchmen over forty years of age, this latter repair was often necessary. The construction of a medial barrier to the internal ring, by a strip of the lower edge of the external oblique, and the suture of the medial end of the falx to Cooper's ligament were regularly done. Fine cotton sutures, interrupted, were used throughout. The external ring was never entirely destroyed, so that the transplanted cord followed an almost transverse course until it entered the scrotum. Alcohol was applied as each layer was closed. Scarpa's fascia was always closed separately. Dead spaces were avoided. Sepsis occurred in 2% of cases, and then it was only slight. Recurrence after three months was less than 2% in 114 cases. A month's rest on the floor was insisted on in every case.

Gall-bladder surgery presented nothing of note.

Liver abscesses were drained as described above. Two large malarial spleens were removed for rupture. In one case the splenic artery had to be

ligated blindly in the lesser sac; the patient recovered. Three kidneys were removed—one for pyonephrosis, one for tuberculosis and one for a stone. The story of our trials with urological conditions is of interest.

The first patient to be submitted to operation for a renal condition was an Australian officer who suffered from severe pain in the left hypochondrium. He gave a history of renal colic, and had a palpable lump to the left of and above the umbilicus, and occasional pyuria. Despite the absence of radiological and chemical facilities, Major Fisher and I agreed that the lump was renal and if the result of the water test was normal we could proceed safely to operation. I removed a large pyonephrosis with a T-shaped calculus blocking the pelvic outlet. The patient recovered slowly.

The next renal case was that of an English boy complaining of severe pain in the left loin, hæmaturia, frequency and strangury. The prostate was large, soft and painful. We had no stains for tubercle bacilli at that time. The patient was discussed at a clinical meeting and it was agreed that he might have a prostatic abscess or urogenital tuberculosis; a wait-and-see policy was advised. A month later he presented a mass in the left loin. Some methylene blue was obtained, he was given an intravenous injection and passed blue urine in twelve minutes. The left kidney was explored and found to be a bag of pus; the ureter was very thick. Nephrectomy was performed. The specimen was a typical tuberculous kidney. Portions stained later showed tubercle bacilli. Frequency of micturition gradually subsided, and after twelve months the wound had healed and the patient was well.

The difficulties in determining the site of a stone, and the adequacy of renal function deterred us from doing more than urgent renal surgery. It is not surprising, therefore, that, when the end came, there were about 65 patients with nephrolithiasis awaiting the ministrations of a properly equipped surgical staff.

Several cystostomies were done. In one case a pea-like adenoma obstructing the bladder outlet was excised and the area was cauterized with a red-hot nail.

Four large obstructing goitres were removed under local anæsthesia. Two laryngeal operations were performed, one an excision of the cord and the other a laryngectomy for carcinoma. In the latter case the patient unfortunately died from lung abscess.

Neurosurgery was undertaken when urgently necessary. Two radial nerves were sutured. Four ulnar nerves were successfully transplanted. The vulnerability of the ulnar nerve, lack of vitamin *B*, may have accounted for many cases of ulnar paresis. I myself had a bilateral ulnar palsy following amœbic dysentery, the vasomotor effects of which are still with me. In the four cases quoted above old injuries were associated with the progressive paralysis. Cranial decompression was done in six cases—two for tumour, two for fits (old injuries), one for persistent cerebral contusion (Japanese beating) and one because of wandering periostitis of the skull.

Of the tumours, one was a pontine glioma invading the cerebellum. The patient died about a fortnight after a cerebellar decompression. The other patient had a glioblastoma of the right frontal lobe, and an osteoplastic flap decompression was done in January, 1945. The patient was cruelly sent to a working camp by the Japanese, and after the capitulation he was flown to the United States, where 500 grammes of tumour were removed. He died a fortnight later, in October, 1945.

Two patients with fits had subdural hæmatomata; they were cured by operation. The patient with persistent cerebral contusion was improved by decompression. The patient with wandering periostitis was relieved of his pain by decompression (extradural). He is an Australian who is now stone deaf, but otherwise quite well.

Two laminectomies were done. One was done for a neurofibroma lying extradurally in the spinal canal. The patient unfortunately had a bed sore before his condition was diagnosed and he developed an abscess in a solitary

kidney. The other laminectomy was exploratory, in the case of myelitis following spinal anæsthesia. Two such cases occurred as a result of the ill-advised experimental use of "Percaine" treated by the physiologist to prevent spore formation. Among twenty patients submitted to spinal anæsthesia with this solution, two developed fatal paralysis. No excuse is offered, but a salutary lesson was learned by all the staff.

The accompanying list of operations calls for no comment. A few chloroform anæsthetics were given. No ether was available, hence spinal anæsthesia was used. "Percaine" in the early stages and "Cutocaine" later were prepared in distilled water as a solution for each individual case. Operations on the upper extremity, neck and head were performed under local anæsthesia.

Amongst 178 amputations in the camp (major) only one case of painful stump was noted. It is too early to comment on the late results.

Considering the debilitated condition of most of the patients submitted to operation and the absence of adequate post-operative nursing facilities, the mortality figure for operations seemed reasonable (see list).

Operations on the stomach, intestine and rectum were of the routine type, as indicated, and call for no comment. Gastro-enterostomy had to be undertaken in several cases of obstruction, but the peptic ulcer problems were left as far as possible to the physicians. Some observations on the peculiarities of certain large perforated ulcers, and the occurrence of posterior wall ulcers of the duodenum will be the subject of a more detailed paper by Major Kranz.

ACKNOWLEDGEMENT.

I wish to thank my surgical colleagues for their work at Nakompaton Surgical Hospital.

List of Operations Performed at Nakompaton Hospital.

Appendicectomy	140	Bladder and prostate	10
Hernia	114	Testis and epididymis	14
Enterostomy	25	Hydrocele	14
Rectal excision	2	Thyreoidectomy	4
Hæmorrhoids	39	Larynx	2
Intestinal obstruction	7	Glands	2
Enterectomy	7	Craniotomy	6
Gastric	13	Laminectomy	2
Cholecystectomy	10	Peripheral nerves	5
Spleen	3	Amputations—	
Pancreas	1	Major	22
Liver abscess	8	Minor	21
Empyema	8	Sequestrectomy	70
Thoracoplasty	2	Compound fractures	3
Phrenic avulsion	1	Varicose veins	30
Lung abscess	1	Feet and joints	23
Nephrectomy	3	Fistulæ, sinus and skin grafts	100
Nephrostomy	1		
Total			896

Eighteen patients operated on died.

SOME ASPECTS OF THE DIAGNOSIS AND TREATMENT OF PROLAPSED INTERVERTEBRAL DISCS.[1]

By H. C. TRUMBLE,
Melbourne.

THE chief symptoms of disorders of the lowest two intervertebral discs are backache and sciatica. It is a matter of some importance, therefore, to know in what proportion of patients complaining of backache or sciatica, or both, the lesion responsible for the symptoms is in an intervertebral disc. A great many different pathological conditions have been supposed to cause backache, and almost as many in the case of sciatica. In the short time at my disposal I can do no more than make a brief reference to the more commonly held theories as to the causation of sciatica.

It has been held by some physicians that typical sciatica, which is defined as a malady of acute or subacute onset characterized by pain in the area of sciatic distribution with tenderness of nerve and muscles and sometimes loss of sensation and weakness of muscles and diminution or loss of the ankle jerk, is due to a true inflammation of the sciatic nerve or the roots entering into its formation. There is, however, no doubt that patients with prolapsed intervertebral discs may present this picture in detail and that successful removal of the disc will result in the disappearance of the signs and symptoms. It is, of course, not possible as a rule to demonstrate conclusively that the nerve is inflamed. It is, therefore, a matter of very great difficulty to prove that true inflammation of the sciatic nerve is present in any particular case.

"Fibrositis" has been supposed to cause sciatica. Here again proof is difficult to obtain and some observers deny the existence of such a condition. Elliott[(1)] claims to have shown by electrical methods that the tender nodules which are sometimes found in muscles are due to localized spasm of the muscle fibres secondary to irritation of the motor nerve supplying the muscle.

Kellgren[(2)] supposes that there is a lesion of some deep structure, such as a ligament, because he has been able to produce sciatic pain by irritating the appropriate ligaments and to relieve pain by injecting local anæsthetics into the damaged tissue. He does not make it clear what is the exact nature of the pathological process affecting the deep structures in question.

Bankart[(3)] supports Putti's theory that in many cases sciatica is due to arthritis affecting the lateral intervertebral joints, and he holds that facetectomy often cures obstinate sciatica. It was pointed out by Walshe[(4)] that demonstration, by means of radiography, of spondylitis in a patient suffering from sciatica does not prove that there is a causal relationship between the two.

Hurst[(5)] held that though, as a rule, there was some organic cause responsible for sciatic pain in the first place, continuance of the pain was due to psychical causes. He held also that patients could be cured by suggestion.

Practically all authorities agree that prolapse of an intervertebral disc may cause sciatica, but estimations of the proportion of cases so caused vary considerably. Dandy[(6)] holds that 95% of all cases of sciatica are caused by disorders of the lowest lumbar discs. He states that in one-third of the

[1] Read at the annual meeting of the Royal Australasian College of Surgeons, Melbourne, on May 14, 1945. Accepted for publication on July 10, 1945.

cases there is prolapse of a *nucleus pulposus,* whilst in the remaining two-thirds what he calls a "concealed disc" is present. Dandy also claims that practically all backaches are caused by disorders of the lumbar discs. The 5% of cases of sciatica not caused by disc disorders are caused by such conditions as tumours of the *cauda equina,* spondylolisthesis *et cetera.* It will be seen that if Dandy's views are accepted there is practically no diagnostic problem at all.

OPERATIVE TREATMENT.

When operation has been decided upon, the exposure is usually carried out by way of a limited laminectomy and extradural approach to the affected disc. Often, however, it is necessary to remove the whole of one or more laminæ and occasionally it may be necessary to employ a transdural approach. If a definite prolapse of the *nucleus pulposus* is found, an incision is made into the lump, loose fragments are extricated, then radical removal of the *nucleus pulposus* is effected. This may be difficult and special instruments are required in order to reach that part of the disc which lies close behind the *dura mater* in the mid-line and on the side opposite the prolapse. It may be wise to make a second approach to the disc on the other side of the theca. If a bulging of the disc is found without any definite prolapse of the *nucleus pulposus,* the *nucleus pulposus* and the accessible posterior part of the *annulus fibrosus* should be removed as thoroughly as possible. It is sometimes difficult to decide whether the bulge of a disc is within normal limits or not.

If no definite prolapse or abnormal bulging of a disc is found, what is to be done? Dandy holds that 66% of cases of sciatica are due to what he calls "concealed discs". He states that when such a condition is present there is abnormal mobility of the vertebral spines; that the disc, when exposed, is found to be adherent to the adjacent nerve, and that it fluctuates when tested with a probe; further, that after incision of the *annulus fibrosus,* a probe passed into the *nucleus pulposus* encounters there little resistance, and, lastly, that the nucleus is found to be composed of a "brown, mushy, necrotic material".

I have not been able to satisfy myself of the validity of these signs. As regards mobility of the spines, I have found that in the normal person there is a range of movement of from three-eighths to one-half of an inch when the spine is in a position about half-way between full flexion and full extension. The movement is practically abolished in full flexion and full extension of the spine. I have never noticed a greater range of movement in patients with proven disorders of discs. One function of an intervertebral disc is to permit of and promote smooth and easy movement of one vertebra upon another, through a range which is limited chiefly by the restraining action of the interspinous and supraspinous ligaments. It is scarcely to be supposed that the movement in question would be made more easily when the disc had been damaged, and it is difficult to see how the range of movement would be increased. I have never found a nerve to be adherent to a disc, though it is quite common to find a nerve closely applied to a bulging disc. Extradural fat probably disappears as a result of pressure. Normal discs may give a sense of fluctuation when the spine is in a position about midway between full extension and full flexion. The fibres of the *annulus fibrosus* are relaxed in this position and bulge somewhat. In full flexion of the spine the fibres become tense, the annulus flattens and "fluctuation" is not obtained. In full extension the annulus bulges more strongly, being squeezed out by the approximation of the posterior margins of the adjacent centra. Again there is no sense of fluctuation. The normal *nucleus*

pulposus offers extraordinarily little resistance to the passage of a probe, and it would be very difficult to decide whether in any particular case the resistance is less than normal. I have never found at operation any *nucleus pulposus* which could be described as being composed of "brown, mushy, necrotic material". On many occasions, after removing large, free, unattached fragments of prolapsed *nucleus pulposus*, I have had them examined microscopically. In all cases the material has been composed of fibro-cartilage with more or less healthy cells. It is wrong, therefore, to describe these fragments as sequestra.

In view of the above reasons I am not prepared as yet to accept Dandy's conception of "concealed discs", and if I cannot find at operation some definite bulging of the disc I do not incise the *annulus fibrosus*. It is interesting to note that in a recent paper[7] Dandy states that he is not sure that "concealed discs" are abnormal.

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DISCUSSION.

LAMBERT ROGERS (Surgeon Captain, Royal Naval Volunteer Reserve): Sciatica, it has been said, never lasts a lifetime and no one dies of it. Rest and the course of time ultimately cause its disappearance, but it may be troublesome for many years.

I have evidence that the disc syndrome may follow exposure to cold and is not always post-traumatic. (A case was quoted.) Rupture of the annulus may possibly be dependent on changes in its chemical or physical constitution, and these may be influenced by such factors as exposure to cold or possibly even vitamin deficiency. Operation is a short cut to rehabilitation, and therefore has an appeal in service cases. In the Royal Navy we have now operated in over fifty cases, and I have personally performed thirty of the operations. Results for the most part have been satisfactory, but not all patients have returned to full general duty.

I believe it is important to perform lumbar puncture in suspected cases and to estimate the protein concentration in the cerebro-spinal fluid. Three of my thirty patients have had tumours, and all had very high protein content of the fluid, that is, over 100 milligrammes per 100 cubic centimetres. None of these patients had urinary symptoms or the typical picture of a *cauda equina* tumour; in fact one had had sciatica for thirteen years and had been regarded by a competent neuropsychiatrist as an hysteric; another had been referred to me by an orthopædic surgeon as suffering from a disc syndrome, and I must say until I had the report of the fluid examination I agreed with his diagnosis; the last patient had had a sacralization removed by an orthopædic surgeon from the fifth lumbar vertebra without relief, and when the patient was referred he was in such intense pain that he was unable to lie down and had sat up all night for three nights. This symptom of persistent pain is a distinction from sciatica due to a disc lesion because those patients are relieved by rest in bed, whereas the patient with a tumour is not.

Finally, I would make the point of removing all the disc, not just the herniated sequestrum. I have had one recurrent case, that of a young officer, who was completely relieved by removal of a sequestrated mass of nuclear material lying under a nerve root. He went back to duty, but returned three months later with the statement that he had turned over in bed and developed exactly the same pain, and therefore asked to be operated on again. Somewhat reluctantly I reexplored and found a further herniation under the same root. The whole disc was removed and he is now free from pain.

R. A. MONEY (Sydney): I wish to urge the necessity for taking a careful and detailed history in these cases and for analysing the symptoms as presented. Where the situation and radiation of the pains indicates a distribution by dermatomes and/or peripheral nerves, I feel that the case should be fully investigated by a neurologist or neurosurgeon, especially bearing in mind the ever-present possibility that the symptoms may be due to a spinal cord tumour. Also, a sane view of these cases must be maintained. I would never agree that every patient with recent and acute "sciatica" should be at once submitted to operation for a prolapsed disc, even though all the necessary clinical signs may be present. It must always be remembered that rest is the fundamental principle and that the majority of patients with sciatica were cured this way long before this operative treatment was advocated.

I agree with the opening speaker's distinction of ruptured and herniated discs, and hold that the long history of low backache with vague radiations down one limb indicates the former condition, whereas the sudden onset, on top of this, of a severe crippling "sciatica" reaching to the foot and toes is indicative of a complete herniation. In nearly every case the diagnosis can, I consider, be arrived at by a careful analysis of symptoms, a thorough neurological examination, and good plain skiagrams. Additional information can be obtained from spinal puncture, from examination of the cerebro-spinal fluid for protein and globulin, and from observations made upon its dynamics by Queckenstedt tests and the reversed Queckenstedt test (as advocated by Love, of the Mayo Clinic). I place a good deal of reliance upon this test to distinguish the "low" sciaticas due to neuritis and fibrositis of the sciatic nerve from those due to pressure on nerve roots. In the former the pains are relieved by the injection of a local anæsthetic solution into the sacral epidural space, whereas in the latter cases these injections produce an exacerbation of pain. I do not favour the use of lipiodol, as to remove it a full laminectomy is usually necessary and the *dura mater* has to be opened, with the added risk of arachnoiditis later. In most cases a limited laminectomy and an extradural approach are sufficient, although as complete removal as possible of the *ligamentum flavum* is an essential step. This type of operation shortens the convalescence considerably and results in very little weakening of the back, a very important point in workers' compensation cases.

DOUGLAS MILLER (Sydney): Experience in army and civil practice of patients who have for months and sometimes years traversed a veritable *via dolorosa* in search of relief from symptoms of sciatica, shows how indifferently the problem may be understood and handled. The first necessity for any medical officer in charge of service or industrial patients is to verify the severity of the complaint. The patient should be admitted to hospital under observation, and on his reactions to rest, activity, the pursuit of pleasure and his request for analgesics an early decision should be made. It would then be advantageous, at least in army medicine, if such patients who are considered genuine in their complaints could be sent to a centre where final treatments and decisions could be made. There are many clinical entities called sciatica, and some of them are undoubtedly pains referred from joints and muscles of the lower part of the back and pelvic girdle. Such patients do not give the typical history of the sciatica of nerve root origin and should be referred to the orthopædic surgeon for appropriate treatment.

The other group of patients give an account of pain which is referred to the area corresponding to one or two nerve roots—usually fifth lumbar or first sacral. Such patients may be regarded as suffering from sciatica of direct nerve origin. The characteristics of such cases are pain, usually starting at some time in the back and later extending along the distribution of the particular nerve root. The pain is often associated with paræsthesiæ in the same area. The pain is severe, it is made worse by coughing, sneezing or straining. It may be eased by a variety of tricks or postures. It usually disturbs sleep and general nutrition. The objective signs are firstly of a patient in obvious distress. Rigidity of the lumbar segment of the spine is nearly always present, with or without scoliosis and limitation of leg movement. Lesègue's sign is constant, loss of ankle jerk very common when the first sacral nerve is involved, and objective sensory disturbance is often demonstrable. This sensory disturbance is seldom absolute, but usually in the nature of a relative analgesia, which may be patchy rather than conforming to an entire dermatome. The patient's delineation of pain and paræsthesiæ is often a more reliable guide to the affected dermatome than is an objective test.

Naffziger's sign of pain referred to a typical area on compression of the jugular veins is inconstant, and it is hard to say what factors make this sign positive.

With such history and such signs a presumptive diagnosis of intervertebral disc syndrome may be made. The surgeon then has to decide on appropriate treatment. It is obvious that such disabilities are capable of spontaneous cure, which may be hastened by, or coincidental with, the host of empirical remedies that have been directed against it. It is also a matter of experience that in many cases the symptoms

continue steadily or intermittently for a very long time and may result in tragic suffering and loss of useful time.

It is my practice to divide patients into two groups, one for conservative treatment and one for early radical treatment. Patients considered fit for conservative treatment are those in whom the condition is mild, those in the early stages, and those who are poor psychological risks for surgery. The conservative treatment used is absolute rest in a plaster of Paris spica for four weeks at least. This mode of treatment is based on a conception that in such cases the pathological change is probably a soft degenerating area in a disc which may be capable of consolidation and repair. There is no doubt that such immobilization gives symptomatic relief and often results in cure. In many cases removal of the plaster is followed by a recurrence of symptoms, which, if sufficiently severe, will indicate operation as the next line of attack.

The cases in which operation is advised are those which have resisted conservative treatment, those in which after a few weeks' rest the pain is still severe, or those in which there is evidence of undoubted pressure on a nerve, as shown by anæsthesia, muscular paralysis, weakness, reflex loss or, more important, visceral disturbance. There comes a time, which should not be too long postponed, when operation should be advised, for with sciatica it does at times seem that a pattern of pain is etched on the sensorium, which even the removal of an obvious lesion may not cure.

Early in the series lipiodol was used pre-operatively in order to confirm the diagnosis and the level. It was, however, very difficult and often impossible totally to remove it. The main dangers of leaving it in the spine are probably medico-legal. As experience has increased, the clinical diagnosis has been made with more confidence, and it is also felt from operative observations that many disc protrusions are too lateral to indent the dural sac. Lipiodol is not now used, and where doubt exists as to the exact level of protrusion it is a very simple matter to explore two levels through a small aperture in the interlaminar space. After some experience a disc protrusion is quite apparent at the end of a blunt exploring instrument. The operation performed entails a minimal disturbance of the spine in exposure of the disc. The first sacral nerve can often be well explored through no more than an interlaminar exposure with removal of the *ligamentum flavum*.

The exposure of the fifth lumbar nerve is more difficult, since it is more deeply placed and requires the removal of a lunate bite out of the adjoining laminæ. Neither exposure can weaken the spine. The technical difficulties of the operation can be considerable, as the field inevitably becomes very small, and only a recourse to orthodox neurosurgical methods is likely to be successful in overcoming them.

The operation performed consists of removal of all protruded and loose fragments of disc and gentle curettage of degenerate disc from the cavity, which is always found underlying the protruded fragment. Attempts at radical or total removal of intervertebral discs are not made. It is felt that the pathological change is often localized to a small area of the disc and total removal may be as illogical and undesirable as would be the total removal of knee cartilage in the treatment of an *osteochondritis dissecans*.

The operative findings have frequently been discussed and their relationship to symptomatology and cure speculated upon. One thing undoubted is that where the nerve is found with a definite lump of disc under it, cramping the normal space in the lateral vertebral angle and lifting the nerve towards the unyielding lateral edge of the *ligamentum flavum*, the removal of this lump of disc will result in immediate cure. The surgeon would be rash who at operation prophesied such certain cure with a less demonstrable pathological condition. In about 80 personal cases in which treatment by surgery was adopted the results from removal of definitely prolapsed disc material have been, with one exception, satisfactory, and usually dramatic in the relief of pain. The exception was a case of very long standing in a soldier who persisted in protestations of pain and developed hysterical stigmata. Cases in which there is no definite disc protrusion, in which no pathological change may be detected or which may be characterized by the soft "concealed disc" of Dandy are often those in which operation is followed by a relief of symptoms on the cause of which we may speculate; but some patients are not relieved. At present it has not been possible pre-operatively to prophesy with surety what is likely to be found. On the basis of the rules already enunciated, 70% of the cases have been "positive" and the remainder "negative" so far as disc protrusion is concerned. As, however, slightly over half of the patients with negative findings have been completely relieved of symptoms and as the operation has been followed by but one death from late pulmonary embolism and no morbidity, exploration in all apparently suitable cases appears to be justified.

COLONEL F. J. CLARK (Perth): I am less conservative in my outlook toward these conditions than the two previous speakers, Mr. Trumble and Surgeon Captain Lambert Rogers. As a result of experience of eighty odd cases in which operation has been

performed, I disagree with Mr. Trumble's summary dismissal of Dandy's "mobility test" as a means for determining the affected disc.

It is useless to talk of "normal mobility" between the intervertebral bodies as a reason for discrediting this test. It must be remembered that patients are placed in a standard position on the operating table and the test is made by determining relative "abnormal mobility" in this position. It is a test which requires experience of many cases in order to assess its full value. (A coloured Ciné film of the test was shown.)

I further disagree with Mr. Trumble on the question of the amount of the affected disc which should be removed and am in complete agreement with Dandy, who advocates removal of as much of the disc as possible. In some of my earlier cases the necessity for this was manifested by the subsequent herniation of the unremoved portion of the disc on the side opposite to that through which the original approach was made. The achievement of complete removal through a unilateral approach is difficult and calls for specially designed instruments, without which the operation should not be undertaken.

The aim of this attempt to remove as much as possible is to establish ultimately firm, fibrous and, if possible, bony union between the adjacent vertebral bodies. Dandy has already shown that complete bony union is possible and I hope shortly to be able to produce X-ray evidence similar to that which Dandy has already shown. To achieve this end I adopt an addition to the technique of Dandy who, apparently, relies completely on scraping or scooping out as much as possible of the disc. An electrically driven side-cutting burr has been devised with the object of burring the surfaces of the adjacent vertebral bodies in order to provide, in the intervertebral space, the blood supply necessary for the osteoblastic processes of bony union. (A coloured Ciné film of the procedure was shown.)

In conclusion, I wish to point out that, if this procedure can achieve satisfactory results in suitable cases of back injury, with or without sciatica, when more conservative methods have failed, it is then infinitely preferable to long-continued conservative treatment in that it restores the patient to an active life with a reasonable prospect of freedom from recurrences, which is more than conservative methods can at present offer.

ERIC PRICE (Melbourne): To avoid confusion it is worth while to remember that sciatica is only a symptom and may be produced in one of two very different ways:

1. Radiation sciatica. In this case pain is referred from lesions of certain structures in the low part of the back into the segmentally corresponding dermatomes of the lower extremity, namely, the fifth lumbar, the first sacral, and the second and third sacral. Such structures fall into two groups: (*a*) the joints of the low part of the back, which are the sacro-iliac and lumbo-sacral and the transverso-iliac and transverso-sacral, if present. (*b*) The myofascial structures of the low part of the back and buttocks.

2. Impingement or mechanical sciatica. Here distal pain results from the mechanical irritation of particular nerve roots. It is distinguishable from radiation sciatica by the appearance of paralytic nerve signs, but may itself be due to several causes, of which nuclear herniation is only one. Of others can be mentioned cord and vertebral tumour, arachnoiditis, foraminal pressure due to facet irregularity, or disc atrophy, and *ligamentum flavum* hypertrophy. This state of affairs is also referred to as radiculitis, and is the basis of Cotunio's disease, with which we are at present concerned.

It will help us further in understanding these cases if we bear in mind that nuclear herniation is really the dramatic mechanical culmination of a preexisting disc lesion. This disc lesion, which may be traumatic, postural, toxic or otherwise degenerative, is responsible for days, months or often years of recurrent low back pain, and is one of the most common causes of the "lame back". With the occurrence of disc rupture the picture changes dramatically. Sciatica, which was never prominent before, is now the urgent symptom, and is of a particular type. The patient complains of a constant burning ache with sudden lancinations, which are typically of a cramp-like nature, on any unguarded movement, such as coughing or sneezing.

An analogy can be made with duodenal ulcer going on to perforation. There is an underlying chronic process with a mechanical sequel. And in both cases the mechanical sequel is apt to divert attention from the fundamental trouble.

At this stage secondary changes appear in certain muscle groups, in the nature of spasm, local tenderness and wasting. These changes occur in the calf, ham and buttock. The cause for this is open for discussion. In my own view it is reflex muscle spasm which is due partly to an effort to achieve a position of comfort, but chiefly to nerve irritation. This muscle spasm is responsible for the straight leg-raising test, and the tenderness is frequently mistaken for nerve tenderness. It varies greatly in intensity, but in time the spasmodic muscles become the site of pathological change of the nature of chronic fatigue, fibrosis and contracture, and of a more or less permanent character.

The point which I wish to stress is that the clinical picture of the patient is made up of three components: the chronic disc lesion, the mechanical disc hernia, and the secondary muscular syndromata.

From this two corollaries will follow. In the first place it is possible to recognize these cases and to undertake treatment before hernia has occurred, that is, while the condition is essentially a diseased disc without mechanical neurological features. It is certain that such disc injury is the physical basis of many chronic industrial and athletic back disabilities, and many of these patients respond to adequate immobilization in a plaster jacket. In the second place, simple removal of the disc hernia may not abolish all the symptoms. Usually the results are excellent, but there may be, especially in older patients, persistent pain in the back of an osteoarthritic character. For this spinal fusion has been advocated in other countries, though it is not my practice. More important perhaps is the persistent stiffness and pain due to secondary changes in the spasmodic muscles, which sometimes requires weeks of physiotherapy.

SURGERY OF THE PATENT DUCTUS ARTERIOSUS.[1]

By Douglas McKay,
Major, Australian Army Medical Corps.

By way of approach to my subject I propose to deal briefly with the embryology and normal process of closure of the *ductus arteriosus.*

During fœtal life, incomplete expansion of the lungs produces a high resistance to blood flow through the pulmonary vascular bed. Therefore it is necessary to have a mechanism whereby blood can by-pass the lungs. This shunt is the *ductus arteriosus,* which diverts blood from the pulmonary artery into the aorta. When the fœtus is born and the lungs expand, the ductus normally closes and all blood passes to the lungs for aeration. If the vessel fails to close, a reversal of flow takes place within the ductus because the pressure in the pulmonary artery is reduced and is now less than that in the aorta.

Normally, in the latter part of fœtal life degenerative changes commence to take place in the ductus, and according to Schaeffer these changes resemble *endarteritis obliterans.* The diminution in size is gradual and takes many weeks, and it is considered that a certain amount of blood actually flows through the lungs before birth.

Christie,[(1)] in an article published in the *American Journal of Diseases of Children* (1930), gave an account of a large series of routine post-mortem examinations performed on babies with the following findings relating to the patency of the *ductus arteriosus*: Up to the age of one month, 44% remained patent. Up to the age of two months, 12% remained patent. Up to the age of eight months, 2% remained patent. He concludes with the statement that if the ductus remains open after the first year of life, it should be regarded as abnormal.

It is frequently stated that the persistence of the ductus is a compensatory mechanism necessitated by some other structural abnormality of the heart, but Abbott,[(2)] in an examination of 242 hearts with a patent ductus, found that over one-third of them showed no other anatomical departure from normal. In such cases there does not appear to be any adequate explanation for the continued patency of the vessel. In this latter series, which comprised 92 cases, the following interesting and important facts emerged: 28 patients died of subacute bacterial endocarditis; 24 died of slow cardiac decompensation; 16 died of rather sudden cardiac failure; two died of rupture of the ductus; 22 died of causes unrelated to the circulatory system. The average age at death was twenty-four years.

Subacute bacterial endocarditis accounts for the high mortality figure of 30%, and the following is thought to be the explanation. Because of the constant strain placed upon the wall of the pulmonary artery by the swirling and impinging of blood currents, a thickening of the intima occurs in the vessel. Later, cholesterol deposition takes place, with the formation of typical atheromatous plaques. These changes occur primarily round the pulmonary end of the ductus, and also on the wall opposite its opening. It is at these sites of intimal damage that bacterial endocarditis is apt to develop.

[1] Read at the annual meeting of the Royal Australasian College of Surgeons on May 14, 1945. Accepted for publication on July 17, 1945.

As justification for a surgical attack on this abnormality, I shall summarize the complications attendant on the presence of a patent *ductus arteriosus.*

1. The existing shunt diverts sufficient blood from the aortic circuit to cause a deficiency of peripheral blood flow. This impairs the nutrition of the growing child and retards physical development.

2. The presence of the cardiac abnormality carried with it a high danger of subacute bacterial infection (*Streptococcus viridans*).

3. The shunt from the aorta to the pulmonary artery places a great burden on the heart by enormously increasing the total amount of blood which the left ventricle must put out per minute, and by increasing the resistance against which the right ventricle must pump blood. Cardiac reserve is thereby reduced and myocardial failure may supervene after one or two decades.

My personal experience in the surgery of the patent ductus is very limited, being confined to three operations performed on children. They were typical cases and fulfilled the requirements laid down by Robert E. Gross.[3]

1. There must be reasonable assurance that the ductus is patent, as is determined by a loud, continuous, machinery murmur in the pulmonic area, accompanied by an increased second pulmonic sound, and a systolic or continuous thrill, which is most intense in the pulmonic region.

2. There should be evidence of congestion in the lung fields by roentgenologic examination.

3. There should be a prominence of the pulmonary artery roentgenologically, though some cases have been reported in which this has been absent.

4. There should be roentgenological evidence of cardiac enlargement, particularly in the region of the left ventricle.

5. There should be a peripheral blood pressure which has an essentially normal systolic level, but a definitely lowered diastolic level.

My first case was that of a girl, aged three years and three months, weighing twenty-one and a quarter pounds, which is about the average weight for a child of one year. An interesting fact about this child was that her mother suffered from what was thought to be German measles when three weeks pregnant. In addition the child had a congenital cataract of the left eye.

The operative technique was that described by Robert E. Gross[3] in his article in the *Annals of Surgery,* 1939.

The anæsthetic was cyclopropane and oxygen given by the endotracheal method, and as soon as the child was anæsthetized a blood transfusion was commenced. The blood ran in slowly throughout the operation and for approximately four hours afterwards, the amount given being 300 cubic centimetres. It was very comforting to feel that a ready supply of blood was at hand. The child was placed on her back, with the left arm extended up alongside the head and a small sandbag beneath the left shoulder. A transverse incision slightly concave upwards was made in the region of the second left intercostal space, extending from sternum to axilla, and the chest was opened through this space. After division of the second and third costal cartilages, a self-retaining rib retractor was inserted and an excellent exposure was obtained. The phrenic and vagus nerves were easily identified. An incision was made in the mediastinal pleura, extending from the root of the lung in an upward direction, and was placed parallel and just posterior to the phrenic nerve. The pleura was dissected up and the interval between the arch of the aorta and the pulmonary artery was sought by blunt dissection with scissors and small cotton-wool swabs on holders. The vagus was picked up and the recurrent laryngeal nerve was found hooking around the ductus, which entered the aorta at a very acute angle, just distal to a point opposite the opening of the left subclavian artery. A plane was located by means of dissecting scissors, and this was further opened by a small cystic duct clamp, which was eventually worked right round the duct from the lateral side. Pressure on the duct between finger tip and clamp caused the immediate disappearance of the thrill. A double ligature of No. 6 braided silk was passed and tied. There was an immediate rise of blood pressure from 110 millimetres of mercury, systolic, and 20 millimetres,

diastolic, to 138 millimetres systolic and 100 diastolic. No attempt was made to close the mediastinal pleura, and the chest wall was sutured in layers.

The child stood the operation very well, and convalescence was uneventful, except for pyrexia for four days, and some hoarseness of her voice, the latter being due to either endotracheal tube irritation or some mild trauma to the recurrent laryngeal nerve.

She sat in a chair six days after operation, and was discharged from hospital one week later. In spite of the ordeal she showed a slight gain in weight during her stay in hospital. Post-operative examination of her heart showed heart action to be less vigorous and less rapid (120-90). The thrill was no longer present, and the original systolic murmur had disappeared. However, a soft systolic murmur was still present. The child possibly had further abnormalities, but the curing of the major one produced great improvement.

A recent communication from her doctor and parents indicates that the soft murmur is still present, but a marked improvement has occurred mentally and physically. She has put on ten pounds in weight in eighteen months, which is approximately the normal gain for a child over this period. X-ray examination of the chest shows diminution both in size of heart and amount of pulmonary congestion.

My second case was that of a girl, aged four years and nine months and weighing thirty-one pounds. (This is about average weight for a child of two years.) The operative technique was the same as in the first case. When the duct was tied, the thrill ceased and blood pressure rose from 110 millimetres of mercury, systolic, and 10 millimetres, diastolic, to 110 millimetres systolic and 90 millimetres diastolic. The convalescence was uneventful and the child was discharged from the hospital fifteen days after operation.

Post-operative X-ray findings were similar to those in the first case. I could not make recent contact with this patient to find out the subsequent history, but I understand she is making good progress.

My third case was that of a girl, aged one year six months, who was also undersized. Early in the operation the child's general condition caused concern, and on several occasions it was necessary to stop the operation and to close the chest with swabs until improvement occurred. The child eventually died on the table before the operation was completed. I am convinced that the operation should not be attempted at this early age.

In conclusion I should like to direct your attention to a variation in the surgical approach which is carried out at the Mayo Clinic.[4] The exposure is through a postero-lateral incision with resection of the posterior two-thirds of the fourth rib.

It is interesting to note that in the last article by Gross,[5] which appeared in *Surgery, Gynecology and Obstetrics*, January, 1944, he described some modifications of technique. The first consisted of placing a piece of unsurfaced cellophane (one-quarter of an inch wide and four layers thick) over the double ligated duct and tying it loosely. The cellophane excites a regional fibrosis and assures the complete shutting off of the ductus. A further refinement of technique consists of an actual division of the ductus, and suture of the ends with a treble layer of fine silk.

This technique is a real advance, and Gross has carried it out in a number of cases without a death. However, I am sure you will all agree it is a more hazardous procedure than simple ligation, and it is doubtful whether it would be wise to attempt it in your early cases.

ACKNOWLEDGEMENT.

I wish to thank the Director-General of Medical Services (Major-General S. R. Burston) for permission to publish this paper.

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DISCUSSION.

B. T. EDYE (Sydney): My attention was first drawn to the surgical treatment of patent *ductus arteriosus* by Dr. Bruce Shallard in 1943. He had, during a trip to the United States of America, visited the clinic of Dr. Robert E. Gross and was there introduced to the subject. I consulted Dr. Gross's original paper and have followed his technique in the operations I have performed, except in a few minor details. This technique, as well as the history of the subject, has been fully described by Major McKay, and we are grateful to him for this, also for the account of his own experiences.

My own contribution consists of ten patients upon whom I was asked to operate by Dr. Shallard. Nine were females and one a male, and their ages ranged from three and a quarter to thirty-five years. There were two deaths, one from hæmorrhage, due to the cutting through of a ligature at the aortic end of the ductus after the pulmonary end had been ligated, and the other from cardiac failure as the operation was nearing completion. Of the remaining eight patients, difficulty was encountered with the first only. This happened when passing the second ligature, which dragged somewhat and apparently lacerated the postero-medial aspect of the ductus. Severe hæmorrhage resulted, but was controlled by digital pressure until the blood was restored by rapid transfusion. The ligatures were then tied and fortunately there was no further hæmorrhage. There is no doubt that great delicacy of touch is needed during the isolation of the ductus, the wall of which may be unexpectedly tenuous. A precaution on which I have learnt to lay great emphasis is the institution of blood transfusion before the operation is actually started. This allows blood to be flown in rapidly in the event of hæmorrhage. I am sure our first patient would have succumbed but for this.

I have had no experience of the posterior approach to the ductus, but can well believe that it has certain advantages over the anterior approach.

NOTES ON THE TREATMENT OF PENETRATING HEAD WOUNDS IN A BASE NEUROSURGICAL UNIT.[1]

By DONALD D. MCKENZIE,
Major, New Zealand Medical Corps.

THE aim of this paper is to give an account of the methods evolved in the treatment of head injuries in the Middle East together with the details of a series of 189 battle casualties from a base neurosurgical unit. These cases came from three different periods, which varied greatly. The first was the Alamein period. In this period the patients had a relatively short transport by air, rail or road, and arrived at the neurosurgical unit in Cairo very quickly, either operated on by general surgeons in the field or, more often, untouched. The second was the period of the Alamein to Tripoli advance. In this the patients were operated on by surgical teams without X-ray facilities, and evacuation became a matter of weeks as the Eighth Army advanced westward. In the latter part air evacuation direct to Cairo became better developed, and these patients with head injuries, having air priority, once again arrived at the neurosurgical unit without having been operated on in the field. The third was the Tripoli, Tunis, Sicily and Italy period. A mobile neurosurgical unit was sent into the field from Tripoli onwards and a section of this unit went with the forward casualty clearing station, so that at this time most patients arriving in base had had adequate neurosurgical service some 2,000 miles away.

This *résumé* is given to explain the varying condition of patients arriving at the base—some operated upon efficiently, some not so efficiently, and some sent for operation. Treatment is conditioned by the service available in the field, by the distance from base, and by the type of evacuation available. It naturally fell into two groups—forward treatment and base treatment—until a neurosurgical unit was sent up and demonstrated by results that base treatment could be supplied at the casualty clearing station level. The writer was fortunate enough to have eight months with a surgical team in the field and over a year in charge of the base neurosurgical unit for the Middle East, observing both types of treatment.

A neurosurgical unit comprised five medical officers — neurosurgeon, anæsthetist, neurologist, and two general duty officers. There are two theatre sisters and a lavish equipment of suitable instruments, diathermy, suction and X-ray apparatus. The unit is attached to a parent unit to supply beds and nursing. In Cairo we had 150 to 200 beds most of the time.

FIRST AID TREATMENT.

First aid treatment amounts to the application of a dressing and the prevention of any undue movement which may precipitate bleeding or further damage. If they do not die in the first few hours from the severity of the cerebral trauma, patients with head wounds recover in a surprising manner. It was my practice during an engagement to leave unconscious patients lying quietly on a stretcher while attending to urgent cases. A few died, but more improved and were treated later. I consider morphine is definitely

[1] Accepted for publication on January 18, 1945.

contraindicated at this stage, as it confuses the issue regarding coma and the state of the pupils.

FORWARD SURGICAL TREATMENT.

Diagnosis is the first step. It is necessary to regard any trivial scalp wound as being potentially a penetrating brain wound and to shave or at least crop the hair to avoid missing multiple wounds. A South African soldier fell unconscious amongst a group at Alamein and passed through several medical officers' hands with his condition undiagnosed. He had a minute occipital scalp wound and on further investigation was found to have a machine-gun bullet in the brain. Another trap for the uninitiated is that perhaps half of the patients with penetrating wounds do not lose consciousness at the time. High velocity fragments cause local injury to the brain only and do not induce the unconsciousness associated with blunt head injuries in which the whole brain receives a jolt. Therefore, the first point is to treat any trivial scalp wound as possibly serious and to search the whole head. Frequently a small spatter of brain tissue is observed close to the wound. The second point is a brief neurological examination, including the state of consciousness. It is a simple matter to record the state of the reflexes—pupils, abdominal and plantar reflexes and knee jerks. Also the state of consciousness as indicated by these reflexes or the response to stimulation. Such observations, with a note of the time, are invaluable in the assessment of the intracranial state at a later stage. Apart from confirming the high pressure of compression, spinal puncture is not a help at this time. If the man can be evacuated and reach a neurosurgical unit within three days, then the wound is excised down to the skull, which is not touched, powder and a "Vaseline" gauze dressing are applied, and the wound is left open. A light plaster cap with the use of only a few turns is the best dressing. It provides some pressure and cannot be removed by the most restless of patients.

Chemotherapy in the form of six grammes of sulphadiazine is given daily—either orally or intravenously if the patient is unconscious. Ascroft gives only three reasons for not evacuating a patient: (*a*) severe shock (resuscitation is rarely needed for head injury alone); (*b*) the fact that urgent operation is indicated either for compression or for injuries to other parts; (*c*) the fact that the patient cannot reach a neurosurgical centre in three days.

TREATMENT IN THE NEUROSURGICAL UNIT.

Patients with varying types of head wound were admitted—the patients with two- or three-day-old injury direct, several patients with week-old wounds operated on by members of the forward neurosurgical unit or operated on by the general surgeon and held because of other injuries. In most cases the following diagnostic investigations were carried out:

(i) Neurological examination, to establish focal damage as well as the general intracranial state.

(ii) X-ray examination. This is the most important of all, and I reiterate the view that no operation should ever be undertaken without a radiological check. Otherwise you do not know what you are looking for and may do too little and have to undertake further operations, or too much and cause unnecessary trauma. Unexpected foreign bodies are often found. The extent of bone fragments is known. There is an important point here—that an apparently sound outer table may have beneath it a shattered inner table.

(iii) Spinal puncture. In recent penetrating wounds spinal puncture is of little help apart from settling any uncertainty about compression, when the pressure of the spinal fluid will be high. In later cases it was always done, the cells and protein content of the fluid giving the clue as to the likelihood of abscess or meningitis.

(iv) Blood examination. A full blood examination was done at the start for various reasons. The hæmoglobin was the indication whether a transfusion was needed on general grounds, and no other measure has such a dramatic effect on the healing of infected wounds as a lessening of the anæmia. The white cell count was of little value in the diagnosis of infection, but was needed as a check for the perhaps considerable dosage of sulphonamide drugs. Incidentally, I have not seen agranulocytosis despite very heavy dosage, and we became less meticulous in checking the blood as time went on.

(v) Air replacement. We had no hesitation in preparing encephalograms or ventriculograms, if indicated, to localize an abscess or the track of a missile relative to the ventricles.

TYPICAL OPERATION ON A PATIENT WITH A RECENT INJURY.

Anæsthesia.—"Pentothal" was usually given intravenously by the drip method, with oxygen freely supplied via a good airway. The drip supplies fluid and more "Pentothal" or blood can be introduced rapidly if required. Local anæsthesia was used rarely.

Preparation of the Head.—Preparation of the head is better done under anæsthesia. It takes time, but it is necessary to use clippers and then to shave the head.

X-Ray Film.—An X-ray film is exhibited in the theatre to check the site and size of the bony breach, number of bony chips, and so on.

Special Instruments.—The special instruments are essentially a diathermy unit and a sucker.

Treatment of the Scalp Wound.—The scalp wound is excised with a minimum of skin edge, but often the deeper layers are infected and traumatized over a larger area. Most of these wounds were puncture wounds and simple to close, but the triradiate extension or reversed S-incision were used in larger wounds to assist closure. The essential thing is to close the scalp in all wounds in two layers—the galea takes the tension and if it cannot be closed then the skin cannot. It is useless to haul the scalp together with big through-and-through sutures—the tension will lead to sloughing and infection. Old infected wounds are best left open.

The Bone.—The usual small breach in the bone is enlarged to the size of the dural tear or to that of the inner table damage—generally the size of a half-crown. This is big enough to work through, and the fibrous scar is firm enough later to obviate bone grafting. We had no occasion to use a bone flap, excising the breach *en bloc*. A burr hole was occasionally required in the cases mentioned in which the outer table was virtually intact, yet the shattered inner table had penetrated the dura.

The Dura.—The dura may appear intact; a slit may be present or an irregular opening with blood clot and brain pouting. As soon as this is touched or the patient strains, this chocolate mass of toothpaste consistency will ooze out interspersed with little fluid gushes. Dirt, hairs, bone chips and metal may appear in the discharge. Little is done to the dura except to remove tags and perhaps open it further for access. It is not sutured in the usual wounds.

The Brain.—The usual condition found is the toothpaste debris in a track, a scattering of bone chips along the track 1·0 to 5·0 centimetres in depth, and a metallic foreign body deeper in still—often on the opposite side or down in the base. In quite a few cases the metallic foreign body has driven the bone chips in but bounced out itself. The surgeon aims to keep within the track and primarily suction is used to clear it. If the track was big enough I used to put my little finger in to feel the bone chips; then I used a narrow band retractor and picked them out. It is surprising how the track opens up and then collapses when the retractor is removed. Finally, after gentle irrigation, the track was powdered with sulphathiazole. It is essential to remove bone chips, especially if they are in a cluster, as they harbor infection. We left them in the ventricle at first, but as a ventriculitis was invariably fatal we made it a rule to remove bone, whatever the situation. On the cultural examination of chips from fifteen closed healed wounds a culture was obtained in seven cases. Metal appears to be self-sterilizing—at any rate it is known rarely to cause trouble and is removed only if it happens to be in the track. Usually it is much more deeply situated, and possibly because of trauma caused by its removal epilepsy was less frequent in the results of the first World War if the metal was left alone. The reaction of cerebral tissue is slow; we found that the track remained as described up to twenty-one days. It is a very different state in a few months, when the track is replaced by a string of fibrous tissue and each chip has to be coaxed out of a fibrous network.

Closure.—To recapitulate, closure involves complete hæmostasis, leaving the dura open, smoothing the bony edge, closing the scalp in two layers with interrupted silk sutures. Drainage was established through a separate stab wound only for a set reason, such as fear of hæmorrhage, infection, or an open ventricle; but usually there was no drainage.

Points about Special Regions.

1. A big proportion of wounds involve the orbit, frontal sinus or both. Here the dura is sutured if possible, or a fascial graft is applied, or a "Vaseline" plug is used, the point being that the subarachnoid space cannot be left open to infection. Then originally the frontal sinus mucosa was removed *in toto* as a source of infection; latterly, if it looked clean, we simply removed the adjacent mucosa. Lastly, if the eyeball was enucleated it was necessary to take half an inch of optic nerve to remove the uveal tract completely and to avoid sympathetic ophthalmia.

2. Wounds near the sagittal or lateral sinus were treated with respect, as they may bleed uncontrollably, or the former may clot and cause palsy of the legs. Also in the removal of chips from the Sylvian fissure region or the medial surface of the lobe grave difficulties were occasionally caused by hæmorrhage from the middle or anterior cerebral vessels.

3. Perforating wounds were treated as two separate wounds. They were not necessarily fatal, as we had a would-be suicide who had two perforating wounds, one from the temple and the other from the mouth through the frontal lobes. He recovered and left the hospital in a much less depressed state.

Chemotherapy.

Sulphadiazine altered the whole picture. We could not be sure of its prophylactic value, but believed that any meningitis could be cured, unless pus was loculated and undrained. We gave six grammes daily for prophylaxis and twelve grammes daily in the presence of meningitis. This was given

orally if possible and intravenously if the patient was unable to swallow, and in either case the cerebro-spinal fluid was checked to maintain a concentration of ten milligrammes *per centum*, which was the minimum necessary. For some undiscovered reason the intrathecal concentration could not be obtained when sulphadiazine was given diluted in a drip. Consequently if the drug was given intravenously, it was given in the concentrated form, which unfortunately clots the blood in the veins rapidly.

Urinary output was kept at least up to thirty ounces, citrate solution was given with any fluid given intravenously, and the urine was watched for red cells, but there was no trouble from kidney damage.

Penicillin was used from Tripoli on—a tube led into the cavity and a few cubic centimetres were instilled twice daily. Of the patients coming back to us, the only difference was that the wounds of those treated with sulphonamides were usually healed and the wounds treated with penicillin had a moist spot where the tube had been. Cairns, writing early this year, states that all we are entitled to say is that the results are not unpromising. He was working on patients with infected wounds not operated upon for many days, but he agreed that the results of sulphonamide therapy and operation up to three days could not be bettered.

Lastly, it is necessary to issue a warning against the use of sulphonamide drugs by the spinal route. Concentrated sulphadiazine has a pH approaching that of caustic soda, and I came across two patients in England with permanent paraplegia from injection of sulphonamide drugs into the spinal theca.

POST-OPERATIVE TREATMENT.

The nursing is very heavy, and we were allowed more than the establishment of nurses. Unconscious patients have to be turned frequently to avoid waterlogging; they have to be fed by nasal tube or intravenously and need constant attention in the early post-operative days. Undue violence or irritation was best controlled by three cubic centimetres of paraldehyde given intravenously, or three grains of "Sodium Luminal". The keynote of the post-operative treatment was to start rehabilitation at once with a psychological build-up and to avoid the development of a neurosis. Men were encouraged to get up as soon as they wished if apyrexial; they were told there was no such thing as headache; and they were set to doing work in the ward, particularly looking after the bed patients. This encouraged the latter to feel that they too would soon be up and about.

All patients with penetrating wounds had a final spinal puncture and encephalographic examination to exclude latent infection; their mental capacity was appraised, and they were then boarded "A" or "B" or were invalided out of the service.

RESULTS.

It is difficult to assess the mortality. Our regimental medical officers estimated that only one out of three patients with head injuries reached a field ambulance. In one battalion only one out of seven lived for a few hours. Eden, operating at our casualty clearing station, had a mortality of 23%, chiefly due to extensive primary cerebral damage. The deaths in this series are really those due to late infection and amount to only 3%. The nearer the front line, the greater the mortality.

Of 189 battle casualty head wounds, 116 were penetrating and 10 perforating. Twenty-seven patients had wounds involving air sinuses. Thirteen lost one eye and one lost both eyes. Fourteen patients developed

meningitis. Five developed abscess. There were six deaths. These were mainly from severe wounds involving the ventricle or other severe wounds of the body were present; in one case a pulmonary embolus was present.

A comparison was made between general surgical unit and neurosurgical units' results. This was not for acrimonious debate, but to justify the provision of a highly specialized team with elaborate equipment in a forward area. General surgeons operated on 55 patients, of whom 29 required a second operation, or roughly one out of two. The neurosurgical team operated on 113 patients, of whom 15 required a second operation, or roughly one out of eight.

Finally, of the 189 patients, 124 were "A" or "B"; 59 were invalided; six died.

Of the 116 patients with penetrating wounds, only 26 were category "A". Of the 10 patients with perforating wounds, two were classified "A", two were classified "B", and six were invalided.

CARCINOMA OF THE PROSTATE: ITS TREATMENT BY MODERN METHODS.[1]

By HENRY MORTENSEN,
Melbourne.

THE growth of the normal and abnormal prostate has been an age-long problem. That the gland, like other structures of the male genital tract, depends for its activity in a large part on testicular hormone has been accepted on clinical and experimental grounds. The attempts of White in the last decade of the nineteenth century to cure cases of benign enlargements of the prostate by castration are well known, as also the proposals of Niehans to deal with a similar condition by the so-called Steinach II operation in ligating the *vasa efferentia* between the testis and the epididymis.

Every individual, male and female, possesses both male and female, that is, androgenic and œstrogenic, hormones. These, in either sex, maintain a degree of balance, and are chemically very similar. The female develops her secondary characteristics because she has in her body more tissues capable of response to the œstrogenic hormones, and the male for a similar reason in respect of the male hormone.

The interstitial cells of the testis, under the influence of the gonadotropic hormone, elaborated by the anterior lobe of the pituitary, are the main production source of the androgenic hormones in the male. The adrenal gland must also be added as a base for this purpose. This has been proved experimentally and clinically by the demonstration of large amounts of these substances excreted in women suffering from virilism, and in association with adrenal tumour.

Œstrin has an inhibiting effect on the gonadotropic function of the anterior lobe of the pituitary and its exhibition in the normal male produces an anti-masculine effect. In the mature male animal œstrin brings about retrogressive and degenerative changes, whilst in the immature it retards the development of sexual maturity.

Randall,[(1)] of Philadelphia, was one of the first to attempt the relief of carcinoma of the prostate clinically by castration. He was not impressed by the results in a small series of cases and did not regard his work as worth publishing until a much later date. Munger[(2)] next reported a series of cases in which irradiation of the testes appeared to produce encouraging results. However, it was not until Huggins[(3)(4)] and his associates published their experimental results that a universal interest was taken in this problem. Working on dogs in which he ingeniously diverted the prostatic secretion, Huggins demonstrated that administration of androgens stimulated prostatic activity and increased the flow of prostatic fluid. The administration of the female hormone œstrogens stopped the flow. Such glands under the influence of androgens showed hyperplasia and metaplasia of epithelium, which histological changes were returned to normal by the exhibition of œstrogens. A similar effect was produced in these cases by castration. Huggins thought that the important factor in these results was a disturbance of the œstrogen-androgen balance. With castration, the main source of androgens was removed. He regarded the adrenals as being a source of œstrogens in the male which would now act relatively unopposed, producing a high œstrogen-

[1] Read at the annual meeting of the Royal Australasian College of Surgeons, Melbourne, on May 14, 1945. Accepted for publication on July 20, 1945.

low androgen relationship. The giving of œstrogen would necessarily produce a comparatively similar result. He reasoned that if the giving of œstrogen would return the artificially induced hyperplasia of the prostate to normal, and as these cells, which form the carcinoma of the prostate in the male, were in the main of an adult type, it was worth while trying the effect of increasing the œstrogen-androgen ratio by one means or another in an attempt to produce retrogression of the carcinoma and its effects.

However, work published in August of last year by Dean[5] and his associates from the Memorial Hospital in New York throws doubt on this mechanism. As a result of a comparison of pre-treatment and post-treatment levels for œstrogen and androgen excretion, it has been found that after castration, instead of the œstrogens remaining the same and the androgens falling, the œstrogens dropped to a half of the pre-operative reading, while the androgens tended to remain the same or even to increase slightly. In patients treated by stilbœstrol, œstrogenic assays revealed an enormous rise, as one would imagine, whilst the androgen level fell.

According to these findings, it would appear then that the two methods of treatment act in a completely different fashion, and this difference may provide an explanation why the patient with recurrent symptoms after castration is not benefited by stilbœstrol, nor the stilbœstrol patient in similar circumstances by castration.

Further interesting work has been produced on the relationship of acid phosphatase and its occurrence in adult prostatic cells. Phosphatase is an enzyme which is capable of hydrolysing various phosphoric esters, and is found in bone, plasma and other tissues. In adult prostatic tissue the figure for this enzyme is extraordinarily high, that is, 500 to 2,500 units' activity per gramme compared with less than five for the kidney, liver and bone. In bone it is commonly found in the alkaline form with a maximum activity at a pH of 9, but in adult prostatic tissue the enzyme has its maximum activity at pH 5 and is therefore known as acid phosphatase. It has been demonstrated by Gomori that the enzyme is present in, and elaborated by, the prostatic glandular epithelium. It is further interesting to note that these high figures are found only in the prostates of man and monkey. Further, this enzyme does not appear in significant amounts until puberty, and therefore high concentrations can be regarded as indicative of physiological maturity of the glandular epithelium. It is normally excreted by way of the prostatic fluid, but its precise physiological role is not known.

In 1936, Gutman[6][7] and his fellow workers noted that tumour cells arising from prostatic cells retain the capacity to elaborate acid phosphatase in high concentration. Large amounts were found not only in the primary tumour, but in distant metastases. Thus it became feasible to detect a primary source of disseminating carcinoma by chemical identification of its specific secretory product in the blood stream. The prostate in these circumstances may be rightly said to have an internal and external secretion.

There is no increase in the serum acid phosphatase content in normal men, in those with benign enlargement of the prostate, or in some cases of malignant prostate. The suggestion is that these particular cases present an intact capsule, preventing the substance from entering the circulation.

That this is not always so is proved by a case which has been reported recently by Nesbit, of Ann Arbor,[8] in which, in association with a falling acid phosphatase level, the patients exhibited gross progressive metastases. The acid phosphatase value of the blood serum has therefore been used diagnostically as a method of estimating the presence of distant metastases and as an indication of the efficacy of treatment. One must be careful to beware of making a diagnosis of carcinoma of the prostate from a high

reading alone, because such a finding may be present if the serum is hæmolysed, or in other diseases. I saw a report recently of a case in which such a diagnosis had been made because of hæmaturia associated with a high acid phosphate reading when on complete urological investigation the patient was proved to have a renal carcinoma from which bleeding was taking place.

This, then, is the theoretical basis on which the treatment of carcinoma is now based. It is possible to reduce androgenic secretion by castration or by testicular irradiation. It is possible to increase the œstrogen-androgen ratio further by the giving of œstrogen, that is, stilbœstrol. It is possible to combine these various methods. Whichever method is used, the results in a large majority of cases are dramatic in the extreme, and no patient, however ill, should be denied treatment. In fact, it may be safely said that the more definite the diagnosis and the greater the degree of metastasis, the more clinical improvement is obtained. Clinically, full remission of all local symptoms due to the growth and those due to metastasis may be expected in a large percentage of cases.

The patient's general condition shows rapid improvement. He often develops a ravenous appetite and gains of weight of two stone and over are not unusual in a period of two months. Coupled with this, strength and colour rapidly return. Symptoms due to metastases—for example, root pains—rapidly clear, and in more than one of my cases pain has been relieved immediately after the institution of treatment. Secondaries in lymph glands have become impalpable and in one of my earliest cases a huge extension of growth along the side wall of the pelvis, which could be felt in the iliac fossa, literally melted away within three weeks.

Locally the symptoms of obstruction and irritation are the most prominent. Those due to irritation, such as frequency of micturition, pain and hæmaturia, are relieved in all cases that respond. The gland itself may show marked retrogression in size, accompanied by a diminution or relief of the obstructive symptoms, but more mechanical methods—for example, transurethral resection—are necessary as a rule to free the bladder neck and to relieve the patient of his residual urine.

Histologically, gross retrogressive changes may be readily proved in a study of sections taken before and after treatment. Reduction in the size and staining properties of the carcinoma cells and their nuclei, with loss of nucleoli and mitotic figures, is seen. The protoplasm becomes vacuolated, giving the neoplastic infiltration a honeycombed appearance. The lining membranes rupture and there is coalescence of the vacuoles of contiguous cells.

On the practical side of the problem, as has been stated, methods available are various in the treatment of prostatic carcinoma on an endocrinological basis: firstly, castration; secondly, the suppression of testicular activity by irradiation of the testes; thirdly, the giving of œstrogens by mouth or injections; and fourthly, a combination of the first with the last-mentioned method. The use of irradiation on the testes, whilst simple, is not very satisfactory, since the results produced are relatively temporary. So that left for consideration is the question of castration, the exhibition of stilbœstrol or a combination of these methods. The queries that will require answering are: Which method should be employed? Is there any essential difference between the results in the two methods? How long will relief last in those that respond in the presence of metastases? What difference in length of life is treatment going to make if instituted early, and will early treatment prevent metastases?

As regards the most satisfactory form of treatment, there is little agreement among urologists. As evidence of this, a *questionnaire* was sent out within the last few months to a hundred of the leading urologists in

America.[9] Of the seventy-eight whose replies were of sufficient interest, seventy were in favour of orchidectomy. Of these, twenty-three insisted that the operation should be done early, as soon as diagnosis is established, the remaining forty-seven being convinced that it should be performed late when evidence of metastasis has developed. This latter view is maintained by such authorities as Young, of Baltimore, Braasch, of the Mayo Clinic, and Nesbit, of Ann Arbor. Some, before orchidectomy gave stilbœstrol; others, no treatment at all; some gave stilbœstrol after castration; others, none at all.

Nesbit,[8] who has been interested in the subject for a long while, has published two interesting articles describing the results of two series of cases. In the first series the patients were treated by castration; in the other, a similar series in numbers, diethylstilbœstrol was given in a dosage of one milligramme per day, but larger amounts were given to patients who failed to respond or had exacerbation of symptoms whilst taking this dose. There would appear from this to be no significant differences in subjective response in the two series. The relief of pain and gains in weight are practically the same. The objective changes of regression in the primary tumour and in the metastases appear to be more definite in the orchidectomy series than in the series treated by stilbœstrol. There appears to be a definite decrease in size in the orchidectomy group which is not borne out to such a degree with those using stilbœstrol. The influence on the metastases again rather appears to favour orchidectomy. However, this does not quite correspond with my findings, for I feel that as far as regression of the primary growth is concerned there is very little difference between the two methods. Nesbit comes to the conclusion that neither form of treatment offers any prophylaxis against the development or increase in size of metastases.

Dean,[5] however, from the Memorial Hospital in New York, feels that stilbœstrol seems to cause local regression in the size of the prostatic cancer and reduction in the amount of residual urine, more frequently than castration. He states that prolonged arrest of cancerous activity is more likely to be obtained by stilbœstrol than by castration, so that it has become the standard method of treatment in this hospital. He agrees that a failure of one method of treatment is not followed by success when the other method is employed. In assessment of long-range results it is always well to bear in mind that some cases of prostatic carcinoma without any treatment run an exceptionally long course. Roger Barnes[10] has summarized nearly seven hundred cases, in which 20% of patients had back, hip or perineal pain and 65% had evidence of obstruction. The average time from the onset of symptoms to the beginning of treatment of those treated by resection for relief of prostatic obstruction was twenty-one months. Of patients in this series 30% were living after two years, 25% after three years, 15% after four years, and 10% after five years. Occasional patients live longer still.

My own feelings are that we are dealing with a condition that will inevitably kill. No one can talk, at any rate at this time, of cure of carcinoma by this means. We have at our disposal methods by which the activity of the adult cell forming the carcinoma can be profoundly altered. Therefore, I think that it is only right that treatment should be instituted as early as possible after diagnosis. Until the theory of action of the two methods is cleared up, I would believe that castration should be employed as removing the major portion of the stimulating androgenic hormone. It is found that the patient on stilbœstrol feels so well in a short time that inevitably he ceases to take the tablets. As the removal of the testes will not necessarily reduce the acid phosphatase content of the serum to normal, owing to the presence of androgens elaborated by the adrenals, a maintenance dose of œstrogens, one milligramme per day, should be employed.

I quite agree with McCarthy (quoted by Meads[9]) when he said that "Carcinoma is comparable with a rattlesnake and should be hit with all barrels". If castration is performed by the subcapsular method, it will leave the patient with a desirable cosmetic result.

The questions of treatment of obstructive symptoms may be left if desired until the effects of endocrine therapy are determined, but I prefer to remove the obstructing tissue, and in fact the mass of prostate, endoscopically. The œstrogen that is used is diethylstilbœstrol. This has fewer toxic effects than stilbœstrol. In those cases in which the patient is not operated upon because of refusal, because of economic considerations, or because of that present-day bugbear in private and public hospital practice, lack of beds, then the full treatment is carried out with this drug. As regards dosage I do not think that heroic doses are necessary, and I have never used more than five milligrammes per day taken by mouth in the early stages. After remission of symptoms this dose is dropped to three milligrammes. The giving of the hormone by injection is not necessary and will after a very few injections result in the formation in the blood of an antihormone which will neutralize the result. The dosage is of course empirical, and one is guided by the clinical course and, if available, the results of the acid phosphatase test, both of which methods are reasonably crude.

Many of the patients under treatment for carcinoma of the prostate by œstrogen show effects apart from the actual carcinoma or its metastases.[11] The breasts may become enlarged and painful and the nipples tender. This is due, in the breasts, to a progressive proliferation of the duct epithelium, associated with a considerable œdema of all the tissues and an increase in connective tissue with an increase in vascularity.

A troublesome side effect is the occurrence of œdema of the lower extremities. This may be unilateral or bilateral, and it may even develop in the scrotum or peritoneal cavities. Very small doses of stilbœstrol may produce such a result. This œdema is due to a decrease in the renal excretion of sodium and chloride, which keeps the water in the tissues with a reduction in urine volume. Further, as would be expected, effects are manifested in the testes. The testes themselves may become smaller, and this change is associated with a loss of libido. The patient becomes sterile and this is due to the suppression of spermatogenesis, but it is not a permanent effect. It has been found that rats after the discontinuance of stilbœstrol require an average of forty-seven days for fertility to be established again.

It may be mentioned here that patients who have been castrated may complain of hot flushes similar to those complained of by the female at the menopause. These may be relieved by the exhibition of stilbœstrol in small doses.

As regards results, it has been pointed out that it is still difficult to pass any comments on those patients first seen without obvious metastases. Time and the study of a large series of cases will provide the answers to the query whether early treatment prolongs life or produces cures.

In the cases in which definite symptom-giving metastases are present there is no doubt as to the results. When we consider that of one thousand patients reviewed by Bumpus[12] some years ago, two-thirds were dead in nine months from the time of the first treatment, and compare this with the rapid response and relief of all symptoms experienced by some 80% of patients treated in the modern fashion, we realize what a blessing this treatment is. With regard to the length of time that the improvement holds, it has been my experience that practically all the patients who respond maintain the response for eighteen months. About this time many begin to show signs of further

progression, but it would appear that there is less likelihood of the recurrence of excessively painful symptoms, and death, when it does occur, is more likely to take place as a result of a general failure.

CONCLUSION.

In conclusion, attention is drawn to the magnitude of the possibilities that are opened up by this work on prostatic carcinoma. For the first time in our knowledge a substance given by mouth has been found to have an astounding retrogressive action on frank carcinoma cells. Workers in this field for many years have suspected the hormonal system. It is hoped that by the stimulus that has been received from the information gained in prostatic carcinoma the whole outlook of carcinomatous disease will be altered in the near future.

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DISCUSSION.

JOHN POWER (Brisbane): A series of one hundred and fifty patients suffering from carcinoma of the prostate have been seen by me in public and private practice since the institution of hormonal methods in the treatment of the condition. The routine treatment both in early and late cases which have been proved to be cases of carcinoma has been bilateral orchidectomy and a course of stilbœstrol. Nine milligrammes of this drug are given each day for eleven days, followed by one milligramme night and morning. Results have been very satisfactory. One man, who had worn a tube in his bladder for three years, his pelvic bones being riddled with metastases, left hospital voiding normally and increased in weight by four stone.

G. H. BURNELL (Adelaide): I think the discussion somewhat premature, as sufficient time has not yet elapsed for an adequate evaluation of the results of treatment of prostatic carcinoma by orchidectomy, stilbœstrol therapy or both. I have treated thirty patients, twenty-eight of them by orchidectomy *plus* stilbœstrol, and two by

stilbœstrol therapy alone. My earliest patient is now apparently well, two years after orchidectomy. There can be no dispute as to the immediate benefit to be derived from either or both forms of treatment, by the great majority of patients, but in two of my patients the relief from pain had been so transient that the treatment had not seemed worth while. I have not been able to show, in any case in which bony metastases have been present, the complete resolution of such metastases, which had been described and illustrated in overseas journals. With regard to serum acid phosphatase estimations, in my experience a normal reading is of no value in excluding metastases, but if an initial high reading is obtained and later falls to normal, this fact will be of considerable prognostic significance. It is unfortunate that one of the non-malignant conditions, which may give a high acid phosphatase reading, is Paget's disease, as this is a condition which radiologists find difficult to distinguish from prostatic carcinomatous metastasis.

C. B. MELVILLE (Melbourne): Some years ago, in a review of a large number of cases of prostatic carcinoma, H. C. Bumpus pointed out that if urinary obstruction was overcome by cystostomy or prostatectomy, a definite proportion of the patients lived for years without other treatment.

The results of treatment with stilbœstrol and orchidectomy may thus be assessed by comparing results of a series of cases treated in this way with those quoted by Bumpus. A recent paper by Edwin Alyea has stressed the fact that in every point of comparison there is a striking improvement with modern methods.

An example of this was seen with the first patient in whose treatment I used stilbœstrol. He was admitted to hospital in a dying condition, uræmic and with urinary obstruction, lying helpless because of the pain of the secondary deposits in his bones. A suprapubic catheter was inserted and five milligrammes of diethylstilbœstrol were injected intramuscularly each day. I expected him to die in a few days. However, to everyone's surprise, in a few weeks he walked out of hospital, feeling well and voiding normally; his suprapubic tube had fallen out one day and had not been replaced. Six months later he returned in much the same state as at first, but this time increased doses of stilbœstrol, which he had been taking regularly, and subcapsular orchidectomy had no effect and he died. I believe that this patient's life was prolonged for six months by stilbœstrol. Another patient with a large mass of secondary deposits in supraclavicular, axillary and iliac glands, proven by biopsy, and referred for transurethral resection, was treated with diethylstilbœstrol. Within days his urinary symptoms improved so much that resection became unnecessary and within a few weeks all the enlarged glands had disappeared. He lived for over eighteen months, taking five milligrammes of stilbœstrol by mouth every second day. The glands did not reappear and he died of a widespread dissemination in his lungs. I believe he had an extra year of life, spent in comfort.

These two cases illustrate an impression that I have, that patients with secondary deposits respond dramatically to stilbœstrol, but suddenly there may be a lack of response to the hormone and they are overwhelmed and quickly die.

Of those patients who did not have obvious secondary deposits, whether transurethral resection was needed or not, the majority seem to be progressing in a satisfactory manner on an average maintenance dose of five milligrammes of stilbœstrol every second day. How they as a group will fare remains to be seen. I have used intramuscular injections and tablets by mouth, separately, alternately and together. Usually the preliminary dose is given by injection of five milligrammes a day for three weeks and then the same dose is given by mouth every second day for an indefinite time; occasionally a further series of injections is given. I have reserved orchidectomy for those patients who, for some reason, could not tolerate the stilbœstrol by mouth; several complained of severe nausea, and another had profuse nose-bleeding, which ceased after he was castrated.

The patients undergoing hormonal therapy had suprapubic drainage followed by resection or no treatment to the bladder neck, as was indicated according to their ability to void urine.

Finally, I wish to bring to your notice a very definite impression that I have gained, that the dihydroxy and dipropionate forms of stilbœstrol are very much less effective than the diethylstilbœstrol, which is now almost unobtainable. Several patients who appeared to be losing ground when on the former types immediately picked up again when I was able to obtain and use diethylstilbœstrol.

J. THOMSON TAIT (Melbourne) also took part in the discussion, quoting interesting cases.

IVAN B. JOSE (Adelaide): Even if we take into consideration the natural extreme variability in the clinical course of prostatic carcinoma, it is possible to produce both undoubted clinical evidence of the beneficial effect of stilbœstrol treatment of carcinoma of the prostate and positive microscopic evidence that the epithelial carcinomatous cells

are severely affected by œstrogen therapy—one means of depression of androgen hormones.

In my experience, over a short period, I have not yet been able to claim cures. Occasionally a sudden and fatal increase of toxæmia and dissemination occurs after a period of improvement. In practically every case, from the most extensive generalized metastasizing carcinoma to the case in which local signs only of carcinomatous enlargement of the prostate are present, administration of stilbœstrol causes general improvement in health, sense of well-being, increase in appetite and in weight. Pain in the back or legs, if present, is generally lost or at least minimized. In the worst cases patients who are bedridden are able to become ambulatory, at least for a time.

In metastasizing carcinoma the serum acid phosphatase level invariably drops, usually rapidly, to normal limits. Locally there is usually evidence of shrinkage of the prostate: (*a*) from a reduction in the amount of residual urine; (*b*) often (but not always) from digital examination of the prostate *per rectum*; (*c*) from clearing up of long-standing infection in the urine (by elimination of residual urine). I have not yet seen definite evidence of clearing up of metastases in bone.

My plan of management of carcinoma of the prostate with obstruction and retention of urine is as follows. In the first place indwelling catheter drainage is established. Secondly, injections of stilbœstrol are started, 10 milligrammes being given intramuscularly for seven to ten days. Occasionally it may be advisable to perform castration as well. In the third place, if the patient is still unable to void urine well, transurethral resection is performed, or perineal excision in selected cases. Fourthly, in either case a maintenance dose of stilbœstrol, three milligrammes a day, is given.

It must be borne in mind that, in the infrequent cases in which complete surgical excision of the carcinomatous prostate is possible, radical perineal excision should be performed.

There is no claim to complete cure, but much evidence to support the assertion that in a large proportion of cases regression of the condition occurs or at least a slowing up of the progress of the disease, allowing a prolongation of life in relative comfort.

ACUTE REGIONAL ENTERO-COLITIS WITH A REPORT OF THREE CASES.[1]

By THOMAS F. ROSE,
Major, Australian Army Medical Corps.

IT is the purpose of this paper to discuss the acute type of Crohn's disease of bowel.

Crohn *et alii*[1] originally described a disease which they called regional ileitis and stated that it was confined to the terminal ileum. Though this is true in 80% of cases,[2] any part of the alimentary tract may be affected,[3] including the stomach, duodenum, small and large bowel, appendix and even a Meckel's diverticulum.[4] Consequently, the term regional entero-colitis is a more accurate name.

Crohn in 1932 divided this disease into four groups or types: (*a*) an acute type simulating acute appendicitis, (*b*) a type causing symptoms of ulcerative colitis, (*c*) a stenosing obstructive type, and (*d*) a type associated with persistent fæcal fistulæ in the right iliac fossa. Types (*c*) and (*d*) may give rise to acute symptoms; for instance, type (*c*) may cause acute intestinal obstruction usually supervening on an incomplete chronic obstruction. Acute signs of intestinal perforation may occur in type (*d*), as described by Ginsburg.[5] Again, a patient suffering from chronic Crohn's disease may have another portion of bowel affected by acute Crohn's disease.

This paper, however, is concerned only with those acute cases of Crohn's disease simulating acute appendicitis.

CASE HISTORIES.

Three case reports are presented.

Case 1.

A male, aged thirty-five years, was admitted to hospital with a history of attacks of pain localized to the right iliac fossa and recurring at irregular intervals for two years. Forty-eight hours prior to admission, he was seized with severe pain localized to the right iliac fossa. Nausea and vomiting occurred after the onset of pain, but did not relieve it. There was no history of diarrhœa.

Examination disclosed a sick man with furred tongue and a temperature of 100° F., a pulse rate of 100 per minute and a respiratory rate of 16 per minute.

Tenderness and rigidity were present in the right iliac fossa, but no signs of a mass were found. There was no abdominal distension. Rectal examination disclosed tenderness high up on the right side of the rectum. All other systems were normal. A pre-operative diagnosis of acute appendicitis was made.

Operation was performed through a McBurney incision and disclosed the following:

1. There was much clear free fluid in the abdominal cavity. The fluid was shown later to be sterile on culture.

2. The distal eight inches of the ileum, the caecum, the appendix and the proximal four inches of the ascending colon were plum-coloured, with vascular engorgement, and their walls were thickened with œdema. Numerous subserous ecchymoses were present in the affected area of bowel, which was very friable owing to the œdema, the slightest touch producing fresh hæmorrhages. This area was not sharply demarcated at its upper or lower margins, but passed gradually into normal bowel. There were no fibrinous deposits, no bowel distension and no evidence of obstruction.

3. In the mesentery and mesocolon of the affected bowel, the most conspicuous feature was the enormous hypertrophy of the contained lymph nodes, which were

[1] Accepted for publication on October 17, 1944.

elastic to palpation. The mesentery itself was thick with œdema and the blood vessels were engorged. There was no evidence of vascular thrombosis.

4. The appendix was pelvic in position and was inflamed in the whole of its length. Macroscopic examination after removal showed that all layers were affected by the inflammatory process. There were no contents and the mucosa, though thickened and œdematous, was not ulcerated. Later, microscopic examination of the appendix revealed engorged blood vessels, with œdema and small round-celled infiltration of all coats, the lymph follicles especially being affected. The cells comprised lymphocytes, plasma cells, histiocytes and leucocytes, as described by Hadfield and Garrod.[2]

Later, examination of the appendix by cultural methods revealed no organisms.

5. The mesoappendix was swollen with œdema and red with engorged blood vessels. It is possible that other parts of the bowel were affected, but it was thought wiser not to explore further.

Routine appendicectomy was performed without drainage. Convalescence was uneventful, the temperature rapidly falling to normal in two days.

Attempts to grow *Eberthella typhi*, *Bacterium shigæ* and *flexneri* in cultures from the stools were unsuccessful. Five days after operation the white cell count was 8,000 per cubic millimetre, with 70% neutrophile cells, 25% lymphocytes, 3% eosinophile cells and 2% basophile cells.

This patient was seen three years later. He had no symptoms referable to his gastro-intestinal tract. Radiological examination by follow-through barium meal and barium enema revealed a completely normal bowel.

Case II.

A male, thirty years of age, complained of severe pain commencing in the periumbilical region and rapidly radiating to the right iliac fossa. This pain had been present constantly for the twelve hours before his admission to hospital. He had vomited without relief. There was no history of diarrhœa. He had had attacks of poorly localized abdominal pain for the previous eighteen months.

Examination disclosed a sick man with a temperature of 102° F. and a furred tongue. His pulse rate was 110 per minute and his respiratory rate was 20 per minute. Tenderness and muscular rigidity were present in the right iliac fossa and suprapubic region. Rectal examination disclosed tenderness high up on the right side of the rectum. There was no abdominal distension and no signs of a mass were present. All other systems were normal. A pre-operative diagnosis of acute appendicitis was made.

Operation through a McBurney incision disclosed the following:

1. Much clear free fluid was present under tension in the abdominal cavity.

2. The caecum and ascending colon were normal, but in the distal three feet of the ileum there were three areas of plum-coloured, acutely inflamed, œdematous bowel, each about four inches long, separated by areas of normal bowel. These areas were respectively three feet, two feet, and eight inches from the ileo-caecal junction. There was no bowel distension or obstruction.

3. The mesentery adjacent to these areas presented the same picture as in Case I, with again the marked hypertrophy of the lymph nodes.

4. The appendix was similarly involved in two localized areas, one at the base and the other just proximal to the tip. Both these areas presented the same picture of an acute non-specific inflammatory process affecting all layers. There were no contents in the lumen and the mucosa was not ulcerated.

Routine appendicectomy without drainage was performed. Convalescence was uneventful, the temperature gradually falling to a normal level by the end of the third post-operative day. Unfortunately, facilities for microscopical examination of the appendix or pathological investigation of the patient were unobtainable.

This patient was seen eighteen months later, when he stated that he had had no further symptoms. Abdominal examination was normal and radiological investigation of the gastro-intestinal tract showed no abnormality.

Case III.

A male, aged thirty years, was admitted to hospital with a history of severe generalized abdominal pain for the previous twenty-four hours. This pain was intermittent and cramp-like in character and soon radiated to the right iliac fossa, causing him to feel nauseated without actually vomiting. In the twenty-four hours prior to admission he had three loose motions. These did not contain blood or mucus. Two years previously he had a similar attack lasting one day.

Examination disclosed a sick man with a temperature of 99° F., pulse rate 100 per minute, and respiratory rate 18 per minute. His tongue was furred. Diffuse

tenderness was present all over the abdomen, with a tender, ill-defined swelling in the right iliac fossa. The patient had been placed on sulphaguanidine therapy for the twenty-four hours prior to his admission to hospital, having had twenty grammes without any appreciable effect on his illness.

He was then transferred to another hospital, where I first saw him, forty-eight hours after the commencement of his illness. His tongue was furred, his temperature 99° F., and his pulse rate 100 per minute. Extreme tenderness was present and rigidity was localized to the right iliac fossa. This rigidity masked a very tender, smooth, ill-defined mass, which felt like a distended caecum. Rectal examination disclosed tenderness high up on the right side of the rectum. Other systems were normal. A blood film was unsuccessfully examined for malarial parasites. A white cell count showed 10,000 cells per cubic millimetre, with 80% neutrophile cells, 18% lymphocytes and 2% eosinophile cells. A pre-operative diagnosis of acute appendicitis was made and operation was immediately performed, a McBurney incision being used.

The findings were exactly similar to those of Cases I and II, except that this time the affected area was confined to the distal six inches of the terminal part of the ileum, the caecum and the length of the appendix. The mesentery was affected similarly with the same striking hypertrophy of the lymph nodes. Again there was no evidence of vascular catastrophe, intestinal obstruction or distension.

The free fluid and appendix were found later on cultural examination to be sterile. Microscopic examination of the appendix revealed the same picture of œdema and small round-celled infiltration of all coats. Treatment was by routine appendicectomy without drainage.

Convalescence was uneventful, the temperature at first rising to 102° F. on the second and third post-operative days and falling to normal by the fifth post-operative day. There was no abdominal pain or distension.

No evidence of bacterial or of amœbic dysentery or of salmonella infection could be found on examination or in cultures of the fæces. Repeated blood films were examined for malarial parasites, but without success.

Twelve weeks later the patient reported for observation and stated that he was very well save for a few mild aches in his right iliac fossa in the first month of convalescence. Unfortunately, no facilities were available for radiological examination of the gastro-intestinal tract.

SUMMARY OF THE CASE HISTORIES.

These cases were almost identical with each other except for some minor points of dissimilarity.

All were males in the fourth decade of life. All showed symptoms and signs consistent with the diagnosis of an acute appendicitis. At operation, the living pathological picture was strikingly the same in all patients, namely, an acute non-specific infection of the bowel, involving especially the terminal part of the ileum, the caecum, the ascending colon and the appendix, with much free abdominal fluid and œdema of the involved segments. The mesenteries of the affected portions were likewise involved with great lymph node hypertrophy. It may be noted here that Crohn[2] states that the appendix is not usually involved, though it was involved in all these patients.

In the two cases in which pathological facilities were available no specific organism could be found and histological examination of the affected appendices revealed only a non-specific acute inflammation of small round-celled type. In Case III only, a white cell count revealed a mild neutrophile leucocytosis.

In each instance treatment was the same, namely, appendicectomy with no drainage of the abdomen; and convalescence in all was uneventful.

Follow-up studies varying from three months in Case III to three years in Case I showed no clinical symptoms or signs of the disease becoming chronic, and radiological investigation of the gastro-intestinal tract in Cases I and II revealed no abnormality.

The points of dissimilarity are as follows:

In Case III the patient had only a previous acute attack, whereas the other two had histories of vague abdominal pain for two years.

In Case III only was there a history of diarrhœa preceding the attack. An interesting point to notice is that the patient had been treated with sulphaguanidine unsuccessfully, a finding similar to that of other observers.

Abdominal pain was severe in all cases, causing nausea and vomiting. In Case I it was constantly localized in the right iliac fossa, in Case II it commenced as periumbilical pain and later radiated to the right iliac fossa, and in Case III it was generalized all over the abdomen at first and then it became localized in the right iliac fossa.

Case III was the only one to present a mass in the right iliac fossa, which was later shown to be the thickened, œdematous caecum.

The macroscopic pathology in all cases was the same, but the sites of involvement differed. In Case I the terminal part of the ileum, the caecum, the proximal portion of the ascending colon and the appendix were involved. In Case II isolated segments of the terminal ileum and isolated areas of the appendix only were involved. This is characteristic of the so-called "skip distribution" of the lesion as described by Crohn[3] and Barbour and Stokes,[6] wherein the affected areas of bowel and mesentery are separated by normal areas. In Case III the terminal part of the ileum, the caecum and the whole length of the appendix were involved.

INCIDENCE OF THE CONDITION.

It is difficult to estimate the frequency of acute Crohn's disease, especially the relative frequency of the acute as compared with the chronic disease. Crohn[3] reported 110 cases of regional entero-colitis, of which eleven only were acute. However, it would seem that the acute is far more common than the chronic type.

It may occur at any age. Captain M. Chinner, Australian Army Medical Corps, of Adelaide,[7] had three cases in children aged five, six and ten years. The patients here reported were aged thirty, thirty and thirty-five years.

ÆTIOLOGY.

The actual cause of this disease is quite unknown. Hadfield[8] concludes that it is the result of hyperplasia of the lymphoreticular tissue of the intestine. The submucous lymph follicles are considerably enlarged because of endothelial cell proliferation. In the acute stage, giant cells do not appear. Hadfield states that later there is considerable lymphatic œdema of the submucous coat but little ulceration of the mucosa. The regional lymph nodes show a similar histological picture. Caseation never occurs and tubercle bacilli are never found. These hyperplastic follicles later retrogress and in the chronic stage of Crohn's disease no trace can be found of the lymphoreticular hyperplasia.[9]

PATHOLOGICAL PICTURE IN THE LIVING.

As these acute cases are rarely, if ever, fatal, the pathological picture of the bowel as seen at operation is the important one to bear in mind. Holloway[10] states that the earliest change is the marked œdema with much peritoneal fluid. The next stage is a superimposed moderate inflammation which becomes more pronounced. This is the phase usually seen at operation.[2]-[5][10]-[17] There is much clear free peritoneal fluid. The affected bowel appears to be very inflamed, with all grades of colour, varying from red to purple. The bowel walls are very thick and friable, with multiple subserous hæmorrhages easily induced by light pressure. The mesentery is similarly affected and there is the very characteristic and striking marked hypertrophy of the mesenteric lymph nodes. These nodes are rubbery in consistency. There are no fibrinous patches on the bowel and no necrosis of

bowel wall. There is no evidence of vascular thrombosis or embolism. The microscopic changes are of course rarely seen, except when the appendix is involved, and then the picture is that of an acute non-specific inflammation showing hyperplasia of lymph tissues, œdema of all coats, engorgement of blood vessels and infiltration of the tissues with lymphocytes, plasma cells, histiocytes and leucocytes.

Neutrophile leucocytes are in the minority, in contradistinction to acute bacterial inflammation, in which these cells dominate the microscopic picture.

There are no characteristic changes in the blood picture, which usually presents a mild neutrophile leucocytosis, as in Case III. No organism can be grown from bowel or bowel contents.

SYMPTOMATOLOGY.

Acute Crohn's disease above everything else simulates acute appendicitis. There is a similar acute onset of pain, which may at first be generalized over the abdomen or commence in the epigastric or periumbilical regions. Sooner or later, the pain radiates to and becomes localized in the right iliac fossa. In certain patients (Case I) the pain may commence and remain in the right iliac fossa. This pain is accompanied by nausea or vomiting, which does not relieve it. It may be preceded by diarrhœa (Case III) consisting of fæcal matter only, usually without blood or mucus.

As in acute appendicitis, there may be a previous history of vague abdominal pains (Cases I and II), probably due to a very mild form of the disease, which never progresses beyond Holloway's œdema stage.[10]

Examination will disclose an obviously ill patient with furred tongue and a moderate increase in temperature.

Abdominal examination discloses tenderness which may be generalized or localized in the right iliac fossa. This is accompanied by muscle rigidity, usually localized in the right iliac fossa. A mass may be present, but is not typical of the acute disease. When present, it is usually due to involvement of the caecum or terminal ileum, thickened with œdema.

DIAGNOSIS.

Prior to operation, the acute type of regional entero-colitis must be differentiated from all other causes of the "acute abdomen", but the most important diagnosis is from acute appendicitis, and I am certain that this differentiation is practically impossible. There are only three signs which, if present, may make one suspicious of acute Crohn's disease. These are (*a*) the initial diarrhœa before the onset of pain, (*b*) pain commencing in the right iliac fossa, and (*c*) the presence of a mass in the right iliac fossa. Diarrhœa, contrary to general opinion, is quite common both before and after the onset of pain in acute appendicitis. Pain commencing in the right iliac fossa has been said to be usually not due to acute appendicitis, but that is only a generalization which cannot be applied to individual patients. A mass may be found even in early acute appendicitis owing to the tendency of the omentum to wrap itself round the inflamed appendix.

Consequently, since the dangers incurred from failure to diagnose acute appendicitis are far greater than those incurred in an exploration of the abdomen in a case of acute Crohn's disease, it does not seem to me that one can avoid exploring an abdomen presenting the signs of acute appendicitis which may or may not be due to acute Crohn's disease.

Diagnosis at Operation.

Before diagnosing acute Crohn's disease from the abdominal findings at operation one must consider all diseases which may cause a similar, though

not identical, picture and the following must be excluded: acute appendicitis with inflammation of the adjoining bowel, little known forms of acute localized inflammation of bowel, acute intestinal obstruction, mesenteric thrombosis or embolism, the dysenteries, schistosomiasis of bowel and other tropical diseases.

1. An inflamed appendix sufficient to cause inflammatory changes in the adjoining bowel, such as caecum or terminal part of the ileum, will present an entirely different picture. All signs will point to the acutely inflamed, ruptured or gangrenous appendix as being the primary source of the disease, and the bowel involvement will be obviously secondary to this. Any fluid present will be turbid or frankly purulent. The mesenteric lymph node hypertrophy characteristic of acute Crohn's disease will not be present.

2. There are other rare forms of acute localized enteritis whose pathology, at first glance, may simulate acute Crohn's disease. Closer inspection will show, however, that the mesenteric lymph nodes are not enlarged and the mesentery is not involved. These findings will prevent the diagnosis of acute Crohn's disease.

Such a case was the following.

A Papuan native, aged twenty years, was admitted to hospital under the care of Major R. V. Rickard, Australian Army Medical Corps, with the diagnosis of acute appendicitis. Symptoms were of six hours' duration and there had been no diarrhœa.

A blood film was examined for malarial parasites, but without success.

Operation disclosed much sero-sanguineous fluid in the abdomen with intense inflammation of the distal eighteen inches of the ileum. The bowel was acutely inflamed, with greatly thickened walls, but the mesentery was not affected and its lymph nodes were not enlarged. The blood supply to the bowel was normal. The appendix was normal. The abdomen was immediately closed. The patient died three days later of paralytic ileus in spite of all measures.

Post-mortem examination by Major O. Lanchester, Australian Army Medical Corps, disclosed all systems to be normal except the gastro-intestinal tract, in which the jejunum was greatly dilated. The ileum was injected and its coils were matted together with fibrin. Subserosal hæmorrhages were present in the ileum and its lowest coils appeared gangrenous. The lymph nodules in the submucosa of the ileum were enlarged, but there was no mucosal ulceration. The mesentery was normal and the lymph nodes were not enlarged. No mechanical cause of an intestinal obstruction was present. Later, microscopy revealed only signs of acute non-specific inflammation of bowel, with a predominance of small round cells. No cultural examinations were made.

This was obviously not a case of acute Crohn's disease, though at first sight at operation it appeared to be so; the subsequent course of the illness agreed with the findings, as acute Crohn's disease is essentially a benign condition.

3. In acute intestinal obstruction there is much free fluid, often blood stained, and the bowel may look very inflamed, but it is always distended, its walls are thin, and the cause of the obstruction is usually evident. The mesentery and contained lymph nodes are not affected.

4. In mesenteric thrombosis or embolism the bowel may be plum-coloured, with all the signs of acute inflammation, and there will be much free fluid. However, there are no hypertrophied lymph nodes, and evidence of the arterial embolism or the thrombosed veins will be present.

5. In patients resident or recently resident in tropical countries, one must now think of the dysenteries and other tropical diseases.

In both amœbic and bacterial dysentery, in addition to the large bowel and caecum, the appendix and terminal portion of the ileum may be affected. The bowel presents the picture of acute inflammation, with thickened, œdematous walls, and there may be much clear peritoneal fluid. However, there is an absence of hypertrophied lymph nodes and mesenteric involvement.

Acute bacterial or amœbic dysentery will rarely be operated upon, as the clinical picture leaves no doubt as to the diagnosis, but, in certain instances, the symptomatic picture of acute appendicitis may be seen prior to the occurrence of the dysenteric symptoms. Operation may disclose the caecum only involved at such an early stage, or even the appendix only, and the real diagnosis is not suspected until a later culture of the appendix yields *Bacterium dysenteriæ* or the typical symptoms of dysentery occur.

Certain patients actually suffering from Flexner dysentery may have diarrhœal stools with no blood or mucus and they sometimes develop an acute appendicitis. At operation the rest of the bowel, including the caecum and terminal part of the ileum, is also seen to be very inflamed and acute Crohn's disease may be suspected, especially if pathological facilities have not been available; but here again the absence of enlarged lymph nodes will decide against acute Crohn's disease.

6. Schistosomiasis of bowel, especially when the caecum and appendix are involved, may present the picture of acute appendicitis, both clinically and at operation. The appearance of the bowel and appendix may also simulate acute Crohn's disease, though the absence of enlarged lymph nodes will exclude this diagnosis. The later discovery on microscopic examination of the typical ova in the removed appendix, or their appearance in the fæces, will furnish the correct diagnosis of schistosomiasis. This disease must be considered especially in patients from the Far East.

It has been said that malaria may cause a similar picture in the bowel, but I have never seen such a case, even in areas heavily infected with malaria.

TREATMENT.

From a study of the literature and the cases here presented, it seems that this condition is a benign, self-limiting disease of acute onset which quickly subsides even without active treatment. It may, but usually does not, become chronic and leaves no clinical or radiological ill results.

It is certain that many cases of so-called acute appendicitis, especially those presenting a mass in the right iliac fossa, which have quietly subsided without surgical interference (Oschner-Sherrin treatment) have been in reality cases of acute Crohn's disease. This may explain why one is so astonished and pleased sometimes, when, six weeks later, operation reveals an appendix surprisingly normal and free from adhesions.

These conclusions will therefore lead us to use conservative measures in the treatment.

Thus if one can be sure of the pre-operative diagnosis, the best line of treatment is purely observational, followed by careful follow-up studies to detect those cases which may become chronic. However, as one can never be sure of the pre-operative diagnosis, abdominal exploration must usually be performed and there are a choice of several alternatives: (*a*) immediate closure of the abdomen, (*b*) appendicectomy only, (*c*) appendicectomy and ileostomy, and (*d*) operative measures directed at the bowel itself.

Immediate closure of the abdomen was performed in Captain Chinner's cases previously mentioned, and these children were free of any symptoms some years later.[7] Nevertheless, it seems to me that though no active surgical treatment should be aimed at the bowel itself,[4][10][11][13][17] the appendix should be removed for the following reasons, whether it is involved or not, though we must bear in mind, of course, that appendicectomy will not influence the course of the disease. Firstly, the patient has had an anæsthetic and the abdomen is opened and it is but the matter of a moment to remove the appendix. Secondly, it is a prophylactic measure against later attacks of acute appendicitis which would necessitate another operation. Thirdly,

if the appendix is involved, the lumen may become occluded, causing later acute obstructive appendicitis; and fourthly, if the caecum is involved, the appendix may later become obstructed at its base.

Warnings have been expressed against appendicectomy in acute Crohn's disease, especially if the caecum is affected, owing to the risk of the development of a post-operative fistula. In the two cases of caecal involvement here presented, this did not occur and it must be very rare indeed, especially in view of the fact that the condition always tends towards complete resolution. The same argument does not hold in chronic Crohn's disease, in which post-appendicectomy fistula is well recognized.

Meyer and Rosi[15] agree with conservative treatment of the bowel only if œdema is limited to the bowel wall. If lymph nodes and mesentery are involved, then they hold that more radical measures are needed. With this I cannot agree, because in all my cases and other reported cases results have been good, even though lymph nodes and mesentery were always involved.

Appendicectomy *plus* ileostomy was performed by Probstein and Gruenfeld[16] in three cases with a successful result in each instance. However, there does not seem to be any reason for ileostomy, because there is firstly no evidence of obstruction either before or after operation, and should post-operative distension occur, as may happen after any abdominal operation, then the use of the Miller-Abbott tube is preferable to ileostomy.

Operative measures on the bowel itself have varied from an ileo-transverse colostomy to a right-sided ileo-colonic resection. The objections to the ileo-colic anastomosis are that there may be "skip areas" above the site of anastomosis, there is no obstruction, and these cases resolve so well without operation. The objection to the resection of bowel is that it is a formidable operation with a high mortality, even in a well prepared patient undergoing elective operation. Again, one may miss "skip areas", which are left behind. The importance of these areas is that they are the probable cause of recurrence of this disease after bowel resection.

It is in those cases in which the acute disease becomes chronic that later bowel resection may be indicated, and even then a careful search of all the bowel must be made to leave no affected "skip area" behind.

To summarize the treatment, therefore, if one can be sure of the diagnosis, conservative treatment only should be adopted. If laparotomy is performed, then no surgical treatment is to be directed at the bowel itself, but appendicectomy may be performed. Whichever course is pursued, careful follow-up studies over a period of years[4] are essential in order not to miss those acute cases which will become chronic, and these are apparently quite rare.

PROGNOSIS.

The prognosis as to immediate morbidity and mortality is very good and most cases will resolve.[5] In fact, it is now believed that the acute type of this disease is far more common than was previously thought, many cases of this disease probably being diagnosed as subsiding appendicitis and treated conservatively.

To understand the ultimate prognosis of an individual case, one must consider the following facts. A typical history over a course of years may include vague abdominal pains caused by œdema of bowel (Cases I and II). Then in one attack the inflammatory stage is superimposed and an attack of acute Crohn's disease results. This quickly resolves, but may recur and again resolve (Case III). In a few cases resolution may not occur and so the chronic stage of Crohn's disease appears. No figures are available as to the percentage of patients presenting later chronic symptoms. Crohn[3]

himself gives rather discouraging figures. Of his eleven acute cases in which conservative treatment was adopted, eight patients did poorly, and of these, six had to be operated on for further symptoms. However, other observers have had more encouraging results in their follow-up studies. Crohn's figures do show, however, the necessity for careful follow-up studies.

SUMMARY.

1. Three cases of acute entero-colitis (Crohn's disease) are presented.

2. A discussion of this disease is undertaken, with special regard to ætiology, pathology, treatment and prognosis.

3. On the pathological side, the presence of hypertrophy of the mesenteric lymph nodes is emphasized. It is pointed out that in their absence acute Crohn's disease should not be diagnosed.

4. The difficulties of pre-operative diagnosis are stressed.

5. Conservative treatment of the affected bowel is advised.

6. Prognosis of the acute disease is shown to be good.

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THE EARLY TREATMENT OF BATTLE CASUALTIES OF SOFT TISSUES AND BONE.[1]

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I propose to speak regarding the early treatment of battle casualties, soft tissue wounds, compound fractures and the like, during this war, and to tell of the results obtained more recently in the use of penicillin.

Before one can attempt to criticize results of forward treatment, one should be conversant with the medical set-up in the forward area. One should understand the difficulties experienced in transport of the wounded soldier. The delays in evacuation, both to and from the forward operating station, which are often impossible to overcome, should be fully realized. It is only in a base area that a casualty can be held until his wound has healed and he is fit either to return to the front line or to be evacuated to his homeland.

As an example of the medical arrangement existing, may I describe my first experience of battle casualties, which commenced in Tobruk. In those early days the surgeons of our unit were all new to war surgery. The unit had the good fortune to possess as officer commanding the surgical division a surgeon of sound principles, who was a shrewd observer and who had not forgotten what he had learned in Salonika and France in the 1914-1918 war. In consequence, few breaches of major surgical principles were made, even by the younger surgeons, who were not only new to war surgery, but were by no means experienced in pre-war civil surgery. One soon learned, for example, to view with seriousness tension in soft tissues about a wound, and one realized that tension remaining after operation was completed was frequently fatal to limb or even to life. The tense calf called for a large incision through skin, deep fascia, and often muscle, and it was considered essential in this type of case to inspect and confirm the integrity of the main vessel.

Amputation stumps were never tightly sutured. Guillotine amputations were not performed, the production of an open stump with turned-back equal flaps of skin and subcutaneous tissue being considered more desirable. Then, when infection had subsided, or the risk of infection developing had disappeared, the flaps were turned down and lightly sutured. In this manner reamputation was frequently avoided.

"Vaseline" gauze was not plugged into wounds, thus damming up the exit for discharge. It was used as a surface dressing only, and, if a cavity followed excision, the wound was saucerized and care was taken to leave no overhanging edges. The value of sterile "Vaseline" smeared into the raw surface of an excised soft tissue wound, to keep it open and to promote drainage, was quickly realized, and towards the end of 1941 it was used by many Australian surgeons in the forward areas. In fact several devised grease guns, not unlike those used in automobiles, which could easily be sterilized. "Vaseline" could thus be squirted into deep cavities and along the excised tracks of through-and-through wounds.

Some surgeons at this time used sulphanilamide powder as a local application to combat infection, as the final stage in the operative procedure,

[1] Read at the annual meeting of the Royal Australasian College of Surgeons on May 15, 1945. Accepted for publication on July 18, 1945.

without the employment of sterile "Vaseline". The exponents of this technique believed that the powder inhibited the growth of organisms and so minimized the risk of subsequent infection. Others believed that the blood and serous discharge washed the sulphanilamide out so rapidly that no good effect was obtained by its use. In any case it was compulsory for a course of sulphanilamide to be given by mouth, and when good results accrued in the minimization of infection it was felt that it was the blood sulphanilamide content that really mattered. Other surgeons incorporated their sulphanilamide powder in sterile "Vaseline" in an endeavour to obtain the beneficial effects attributed to both. The criticism here was that the "Vaseline" interfered with the already low solubility and the absorption of the sulphanilamide, and, after a short period of trial, most surgeons reverted to the use of sterile "Vaseline" alone.

The battle between the exponents of *débridement* and those of wide excision of damaged soft tissue was verbally waged many times.

As experience increased, incisions through skin and fascia became larger, excision became more complete, the foreign bodies not found at initial operation became fewer and fewer, and post-operative immobilization of the injured area became more thorough.

The value of blood transfusion to combat the hæmorrhage shock syndrome was soon appreciated, and it was then that the oft-repeated remark by one of my teachers became really apparent: "If there is anything better than one pint of blood, it is two pints of blood." Doubtless this is a lesson he learnt in the last war.

With a compound fracture the most important objects of initial operation were adequate excision of damaged soft tissue, the minimal removal of comminuted bone, the production of efficient drainage and complete immobilization. If perfect anatomical reduction of the fracture was easily obtained, it was of course carried out; otherwise it was left for the surgeon at the base hospital.

The methods of immobilization varied according to circumstances and the materials available, and to a large extent according to the nature and manner of the subsequent move of the patient to the rear. For example, in Tobruk, an orthopædic frame was available, there was no shortage of plaster bandages, and the evacuation to the base necessitated many short moves—to ambulance, to barge, to destroyer, to ambulance, to train. Therefore, in this campaign the limb of the patient with a compound fracture of the femur was as a routine immobilized for transport in a plaster of Paris spica.

The fractured tibia was immobilized in an above-the-knee slab, with round-and-round plaster. This extended beyond the toes on the sole of the foot and was not infrequently split if the surgeon feared subsequent swelling in the distal part of the extremity.

The penetrating wound of the knee joint was immobilized in one of two ways. Firstly, a plaster spica extending to beyond the toes and including the sound thigh was used. Or secondly, a plaster gutter was applied from a high level on the thigh to beyond the toes, with the plastered limb slung in a Thomas splint and with strapping extension from below the knee to the end of the splint.

With the injured hand, the minimal excision compatible with safety was carried out. No healthy skin of a destroyed digit was ever excised, but the finger was filleted and the skin was loosely retained by interrupted suture to cover any neighbouring defect.

The fractured forearm was immobilized in a next-to-skin slab and round-and-round plaster from the palm of the hand to a high level on the arm. The metacarpo-phalangeal joints were never extended, and the plaster was not carried further distally than the proximal crease of the palm.

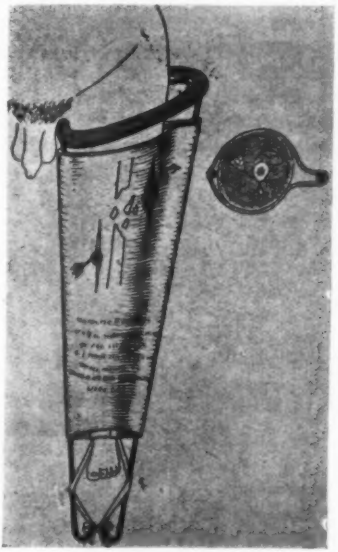

FIGURE I. Tobruk splint. For simplicity the footpiece is omitted from the main drawing and the padding and slings from the cross section, which shows the upper third of the thigh. (After W. H. Ogilvie.)

The fractured humerus was immobilized either by the two-towel method, with the arm at the side, or by a clove hitch sling from wrist to neck, together with a plaster shell cast over the shoulder, arm and lateral chest wall. Neither of these two types of fixation, however, proved altogether satisfactory, and towards the end of our stay in the Middle East they were abandoned in favour of the shoulder plaster spica with the arm flexed to about 40° at the shoulder, and internally rotated, so that the forearm and hand were carried in front of the body, the elbow being at a right angle. In this way the soldier could be transported by stretcher without fear of his arm being bumped by passing objects.

Before leaving the question of immobilization, one must mention the "Tobruk" plaster. It was a method of immobilizing the lower limb for transport in a full-length plaster case suspended in a Thomas splint, with no extension, and fixed to the splint both above and below the knee, by round-and-round plaster bandages passing over the limb and bars of the splint. (See Figures I and II.)

It was never adopted with much enthusiasm by Australian surgeons in its initial form; but now, after being twice modified, it is used as a routine in the evacuation of British battle casualties with compound fractured femurs from Europe.

FIGURE II. The Tobruk plaster fixed to a Thomas's splint by circular cuff of plaster around the cast and the bars of the splint. This partial combination of the Tobruk and double-cuff plaster is a popular and efficient modification. (From "British War Office Memorandum of Surgery", 1944.)

This, then, was the technique adopted by Australian forward surgeons in the treatment of soft tissue and bone and joint war wounds on the return of the Australian Imperial Force from the Middle East, and these principles were carried out in the earlier New Guinea campaigns. Here the casualty was sometimes delayed up to several days before he reached the forward surgeon. In these campaigns experience showed that it was not only possible, but was essential to carry out excision of wounds much later than was previously thought advisable. It was found that wounds could with safety be excised as late as seventy-two hours after the injury had been received. It was again stressed that in all instances the oral administration of sulphanilamide was to be a rigid routine, and it was felt that with this therapy late excision was rendered more safe.

In soft tissue wounds in less vulnerable areas the immobilized excised wound was very often allowed to heal by secondary intention; this took many weeks, even when the wound was small. The time taken for the wound to heal depended to some extent on its depth and the degree of the infection present.

Sometimes, after several weeks, when infection had subsided, either secondary suture was practised or, where the shallowness of the excised area did not permit this, skin grafting was carried out, the hospital stay of the patient being thereby shortened by many weeks. It was well appreciated that before this grafting could be successfully performed, the wound had to be free from streptococci, and it was in this pre-grafting stage, in my opinion, that the local application of sulphanilamide powder was of real value.

In soft tissue wounds in more vulnerable areas, for example the buttock, infection was responsible for great delay in healing. Consequently, secondary suture not infrequently broke down and skin graft failed to take.

In compound fractures bone was left exposed in the depths of the wound, localized osteomyelitis at the fracture site developed, and many months often ensued before sequestra separated and the fracture had healed.

The healing of open amputation stumps was delayed until the subsidence of the infection, when flaps could be turned down and sutured.

Septicæmia as a direct sequel occurred very seldom, and the reduction in frequency in the development of this serious complication when compared with the last war, I think, was due to two factors. The first was immediate and continued oral sulphanilamide therapy. The second was the strict adherence to the principle of non-suture of excised wounds, thus abolishing tension and minimizing the retention of blood clot in a potentially infected area.

Early in 1944, in the later New Guinea campaigns, penicillin first became available in small quantities for the use of the forward surgeons. A list of organisms sensitive to the drug was circularized, but, as supplies were in the initial stages so short, the Director-General made it compulsory for sensitivity tests to be carried out *in vitro* before the drug was to be used *in vivo*.

The methods of use of penicillin at this stage were: (*a*) locally as a powder, 5,000 units to the gramme in sterile sulphanilamide powder; (*b*) locally in solution, 250 units to the cubic centimetre of normal saline solution; (*c*) parenterally, either by repeated intramuscular or intravenous injection.

It was pointed out that subcutaneous injection was useless, as absorption was too slow. It was advised that intramuscular injection was more efficient than intravenous, and at first two-hourly doses of 10,000 units in two cubic centimetres of saline solution were recommended, the total amount to be given varying between half a million and one million units. Later, 15,000 units given every three hours were found to produce an equivalent blood concentration, and this dosage was then recommended, the patient being saved a certain number of hypodermic needle pricks in consequence. Later still, methods of continuous intramuscular administration were perfected, the patient being given either 100,000 or 200,000 units daily. The apparatus used is shown in Figure III.

The first supply was made available to an Australian general hospital in Port Moresby when casualties from the Finschhafen battle area were arriving at the hospital. These patients had had their initial surgery and arrived about seven days after being wounded.

The supply of the drug being short, the more economical local application only was used. The method of application was by solution through fine rubber tubes (four to six gauge) introduced to the depths, the wound being

secondarily sutured, with no attempt being made to obliterate dead space. Three cubic centimetres (750 units) of penicillin solution were introduced daily through each tube, the number of tubes used depending upon the size of the wound. Instillation continued daily for seven days, after which time the dressings, sutures and tubes were removed. During this seven-day period the general constitutional signs of infection, when present, were observed to subside.

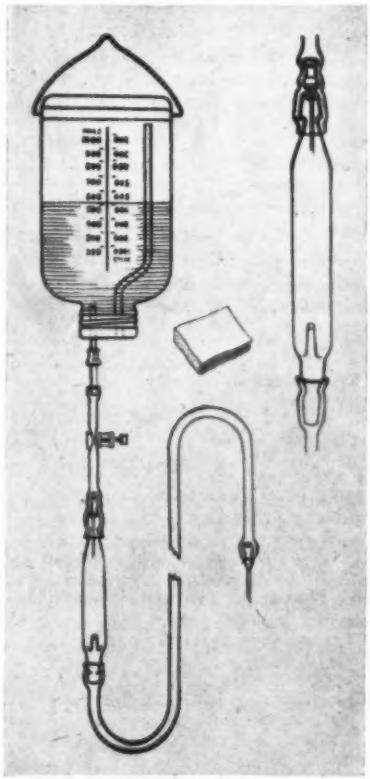

FIGURE III. Apparatus used for continuous administration of penicillin.

Union of the wounds had occurred by first intention, but small tube sinuses persisted. Some became dry and healed within a few days.

In uncomplicated soft tissue wounds of the extremities the patients were discharged to a convalescent depot after another fourteen to twenty-one days, and after a few weeks they were fit once more for duty. In the more severe soft tissue wounds of the more vulnerable areas, such as the buttock, the immediate results of this line of treatment were truly remarkable. Large infected granulating wounds were turned into firmly healed linear scars within the space of ten to fourteen days, and in this type of case hospitalization was lessened by very many weeks.

In Europe during 1944 the experiences of the forward surgeons have been similar. They, of course, have had a far greater number of casualties, and every day their reports are appearing. Their figures and claims on first impressions are staggering, but I, following upon my small experience, am convinced that they are correct. For example, one report covers 25,000 cases of soft tissue wounds in which delayed primary suture was carried out, with healing in 95%.

About this time the consulting surgeon visited a forward operating team on the north coast of the island, taking with him a small supply of penicillin in order to determine its efficacy in primarily sutured wounds. Some eight patients were treated, the method of application being by freely powdering the excised wound with penicillin-sulphanilamide powder (5,000 units to the gramme) and then suturing.

These patients reached base within the week, and seven days after operation their first dressings were performed. In all cases the wounds were healed, and in three some redness and œdema were present. In these no signs of gross constitutional upset existed, so it was thought advisable to leave the sutures for another few days. In the remainder the sutures were removed on the seventh day, and in all convalescence was no longer than three or four weeks from the time of injury.

In the present New Guinea, New Britain, Bougainville and Borneo campaigns adequate penicillin supplies are available for the treatment of all

battle casualties, therefore it is no longer considered necessary for laboratory sensitivity tests to be performed. Now, if the local or general condition of the patient warrants, orders demand that he be given an adequate course intramuscularly. At present, the accepted procedure in the forward area is: primary excision and suture, penicillin given both locally and parenterally, provided of course that the patient can be closely watched for the next few days. If a long carry to transport the patient back to a casualty clearing station or forward hospital is contemplated shortly after operation, and there are no opportunities for treatment *en route*, the practice is to carry out wide excision with penicillin powder applied locally, and a large intramuscular dose, say 50,000 units. The wound is left widely open and delayed primary suture is carried out at the base.

No longer, therefore, is it necessary to wait many weeks until infection has subsided before a wound can be safely closed. In fact, the term "secondary suture" may now be replaced by "delayed primary suture". The success of this suture depends upon the efficiency of the surgery at the front; and efficient surgery at the front depends to some extent upon the operation being performed within a reasonable time of infliction of a wound. Experience in Italy has shown that the optimum time for this delayed suture is upon the fourth day.

Results of this type of treatment have been so successful that it was felt justifiable to try the same method for wounds complicated by injury to bone, and it has been conclusively shown that compound fractures have behaved in a similar manner to uncomplicated flesh wounds.

Several patients from recent campaigns treated in this way have reached Melbourne, and in most the soft tissues are firmly healed, and in these there is no evidence of traumatic osteomyelitis about the fractured bone ends. I am convinced that complete closure of the skin gives by far the best chance of early healing and avoidance of bone infection.

Personally, I have had no experience of fractured femurs treated with penicillin, but reports are available of results obtained in Italy, France and England, as well as in New Guinea. The progress of the patient with this type of wound has been in all ways comparable with that of the casualty with the compound fractured tibia.

SUMMARY.

To summarize, it is already abundantly clear that since the advent of penicillin one may expect soft tissue wounds to heal more quickly, with less scarring both superficial and deep, and with greater speed in recovery of function, with a shorter period of hospitalization, and therefore with a speedier return of the soldier to the front line.

In compound fractures experience has shown that the correct forward treatment is now to convert an open fracture into a closed fracture as speedily as is compatible with safety to the patient.

One has been led to hope that traumatic osteomyelitis will be greatly reduced in future campaigns, that sequestration will be less, and that chronic sinuses passing down to bone will be seldom seen.

It cannot be too strongly stressed that although penicillin has revolutionized the results of forward surgery, it does not permit the forward surgeon to be any way careless in his major principles. His excisions must be as thorough, his search for foreign material as diligent, and his post-operative fixation of the injured limb as complete as ever.

In conclusion, may I quote an extract from a letter just received from a surgeon at one of our forward hospitals.

One thing which struck me very much while doing a round with Colonel Littlejohn was the comparison with a similar round done with him in Warwick, after the Kokoda fighting. At that time nearly every wound seen, soft tissue or otherwise, was discharging, and those suffering from extensive compound fractures looked sick, whereas today a very large majority of all wounds are healed or practically so. This has been especially noticeable in the perforating wounds of hands or feet, healing and, more important, return of function and return to unit, therefore, have been considerably accelerated.

ACKNOWLEDGEMENT.

I wish to thank the Director-General of Medical Services for his consent to the publication of this paper.

DISCUSSION.

R. OFFICER: Lieutenant-Colonel Renou has said that the treatment of battle casualties varies with conditions and supplies. One form of treatment may be impossible under one set of conditions, and one must be conversant with those conditions before attempting to criticize the treatment carried out on casualties. As an instance, one frequently heard surgeons condemn the evacuation from Tobruk of patients in plaster spicas. But when it is realized that the evacuation involved a sea journey in unsafe waters as well as frequent shifting of the patient from ambulance to destroyer, to ambulance train *et cetera*, it will be seen that splintage with plaster spica was the only method possible for compound fractures of the femur.

One has heard that the use of a mixture of sulphapyridine powder and "Vaseline" is ineffective. In the early days of campaigns in the Middle East sulphonamides were available only in tablet form. These tablets were crushed for use in wounds. The excipient in the tablets when mixed with blood formed a firm jelly-like plug in wounds. Many times one saw considerable quantities of pus dammed up behind such plugs. In order to avoid this, sulphapyridine was mixed with equal parts of "Vaseline" and paraffin oil to give a 20% suspension. Despite the criticism that the oil would render the sulphonamide ineffective, this paste proved very effective. It was also more easy to fill a cavity with this paste than with "Vaseline".

Much has been written about the surgical treatment of wounds, and various terms, for example, excision, *débridement* and trimming, are in vogue. For wounds not already suppurating, excision, thorough and complete, is the method that should always be adopted. In compound fractures all detached fragments of bone should be removed.

One of the greatest problems in treatment of casualties was the immobilization of fractured limbs so that the patients could be transported long distances under the unfavourable conditions prevailing. Where sea travel was not involved, the best method of immobilizing fractured femurs was with fixed extension in a Thomas splint. Extension was maintained by means of a Kirschner's wire through the tibial crest. The splint was slung from the stretchers by means of two stretcher suspension bars, one at the level of the knee and one at the foot. One bar is insufficient on account of the springiness of the splint. Fractured humeri were immobilized by applying a plaster splint from the acromion to the wrist. The arm was then fixed to the side by bandaging the chest and arm with plaster bandages in the form of a figure of eight.

During the last war many deaths and much morbidity were caused by infection of wounds with streptococci. This has now been almost eliminated by the use of sulphonamides. The majority of wounds now are infected with staphylococci. It is to be hoped that the use of penicillin will now reduce infections by this organism to a similar degree.

LIEUTENANT-COLONEL B. K. RANK: Lieutenant-Colonel Renou ended his paper with a triumphal note of "penicillin". I noted one word for comment—he spoke of penicillin treatment as being "revolutionary". I consider it a stage in an evolution over all this war period of our attitude and knowledge concerning the prevention and treatment of wound sepsis.

Penicillin has produced the trigger effect, so that we are now sufficiently satisfied with prevention and control of wound sepsis to cast aside the safety methods of leaving battle wounds open for secondary spontaneous or surgical healing, the mal-effects of which have produced a large bulk of the work in the special plastic units of the Australian Army Medical Corps.

Of the long train of surgeons who handle any battle casualty, we have always been the guard's van. This offers a unique opportunity to observe and follow up the

work of many surgeons and see what works out best and what not so well for the end result. We have seen enough of the problems of secondary wound closure, of chronic wounds and of scar disabilities attributable to delayed healing, to realize the enormous economy and advantage that must follow any extension of the methods of primary closure to war wounds.

Concerning such primary closure, certain generalities are already obvious. The unsuccessful primary closures covered by penicillin which I have seen, are failures because of the suturing, and not the fault of the penicillin. Wound excision is still of the same importance. For brisk first intention healing no wound compares with that of a clean surgical scalpel. Any light "trimming" which leaves scraggy and traumatized skin edges is inadequate. Previous widely used methods of "a few silkworm gut stitches" must be replaced by a much higher technical standard of wound closure. Penicillin also permits of a wider application in the use of small flaps and grafts in primary closure. This is noteworthy in hand injuries where any bone, tendon or joint left bare is later lost by failing blood supply and secondary infection. These have been the causes of most delays in spontaneous or surgical healing, and have often indicated secondary *débridement*. Even if further local skin incisions are required to manœuvre a local flap, a small amount of added skin scar can always be better dealt with and will leave less secondary mal-effect than an exposed tendon or bare bone end.

FIGURE I.

There is one inherent disadvantage in war surgery which still has its untoward effects. I refer to discontinuity of treatment and management on the inevitable lines of communication. Though principles may remain uniform, there is no accounting for individual interpretation. An extension of air transport will help enormously in this respect. Open amputation stumps especially suffer on this score. The battle casualty has often of necessity to have his amputation where and as best he can. "Site of election" may have some meaning in an amputation for diabetic gangrene; it has no meaning for battle casualties. No casualty is more obviously "D" class, and the patient who has been subjected to an amputation is soon written up and waiting for onward movement. On the line of communication he may not be long enough anywhere to receive the adequate secondary closure of his open stump, or other accessory measures of secondary treatment, such as soft tissue traction. In the past a goodly number of these have arrived in base hospitals with a chronic wound adherent to bone ends, as shown in Figure I, well fixed by surrounding scar of secondary intention healing which has proceeded so far but no farther. It has been difficult to determine the correct management in such cases. Sepsis of bone ends may sometimes be the reason for failure of wound healing, as indeed it often is responsible for secondary sequestration, sinus formation and adherent terminal scars. However, much of this bone sepsis would be prevented if the bare bone ends were early and adequately covered by something more than a lamina of granulation tissue. I believe much of this bone sepsis is in its origin secondary to this relative exposure and delayed healing. Once terminal bone sepsis is established, not only is spontaneous healing unduly protracted, but any surgical procedure involving further shortening of the bone or its trimming is often a failure which can be ill afforded with many stumps

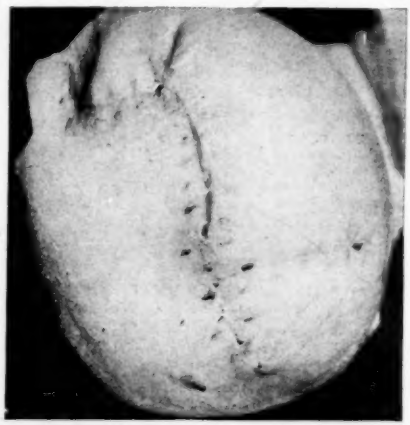

FIGURE II.

already too short. In such circumstances all army surgeons have had secondary stump closures break down again. I have shown a number of these stumps to surgeons of the last war. Some said they would not operate in such cases, others that healing would never occur properly without operation. Alongside this confliction of experience is the attitude of army economy, urging the earliest possible boarding and discharge of such men, which cannot be until they are supplied with a limb; that is, the stump must be healed.

After many disappointments with reamputation of such stumps, though I would undertake any soft tissue procedure—and we have used all types and combinations of free graft and flap to cover amputation stumps, as temporary or permanent measures—I would never carry out any secondary closure, local plastic procedure or flap migration on an unhealed stump which involved a bone section. It has been better to use palliative grafts where possible to hasten or effect healing and to wait, no matter how long, until it seemed that sepsis was inactive and that reamputation or trimming would be successful.

I was keen to determine what effect penicillin would have on these operations, which in the past have not been highly satisfactory, even with sulphonamides. We have done a number of such reamputations involving the section of major bones, and covered by parenteral administration of penicillin with or without its local application. All have done well with no secondary breakdown. Figure II shows a typical result of bone shortening and plastic closure with local flaps under these conditions. I know they are only a few cases, but I am convinced these are examples of the directions in which penicillin will be most helpful. It allows us to do some of the things we have been wanting to do, but which in the past have been ill considered.

This evolution in the prevention and control of wound sepsis should be accepted as a stimulus to the application of more finesse in surgery to apply surgical methods to obtain more acutely earlier and better results.

WING COMMANDER J. GRAYTON BROWN (Royal Australian Air Force): I should like to discuss experiences in the treatment of battle casualties in the Royal Australian Air Force and also the evacuation of casualties by air.

The type of wounds are very similar to those found in army personnel, with the exception of the wounds caused by explosive shells either from other aircraft or anti-aircraft guns. The shells explode when they strike the fuselage or wings of the aircraft and scatter the aluminium of the stressed "skin" of the plane, causing multiple puncture wounds, and the injured area is powdered with small particles of aluminium which cannot possibly be removed at operation. However, no harm results from their presence, and numerous pilots are back on duty, although an X-ray photograph of their old wounds would give almost a "frosted glass" appearance.

I should like to comment on the local administration of penicillin through tubes sewn into wounds. This method was employed for a brief period, but was abandoned after several troublesome pyocyaneous infections, and chronic sinuses were experienced.

Early secondary closure of wounds is very important. The wound should be closed as soon as possible after cultures have been found to contain no significant organisms. The closure may be either by suture or, if this is impossible or involves too much tension, then simple split skin grafts should be used. It is particularly important to close compound fractures as soon as possible.

The wounds were found to be extraordinarily clean when the first inspection took place prior to secondary closure. From every wound culture was attempted and at this stage a small growth of *Staphylococcus albus* was often found and occasionally hæmolytic staphylococci, but only rarely were streptococci grown from wounds of air crew in New Guinea.

Although at first the army rule of never carrying out a primary suture of any wound was rigidly observed, it became obvious that Royal Australian Air Force hospitals were receiving casualties from air accidents or enemy action almost as soon as hospitals in capital cities receive injured civilians. For example, an air gunner who was wounded in action over Rabaul at 4.30 o'clock a.m. was in our hospital at Milne Bay at 9.15 a.m. The distance is further than from Sydney to Melbourne.

My first primary suture did not require any courage on my part, as it was carried out on a patient suffering from a large sucking wound of the chest, who had been admitted to hospital one and a half hours after injury. After limited excision of the wound and the application of penicillin and sulphanilamide powder, the wound was closed by primary suture. Penicillin was administered by the continuous intramuscular method immediately following operation. The wound healed surprisingly well, exhibiting just a slight amount of reddening at the edges, with a little serous exudate during the first few days. Following this case, whenever suitable wounds were received, primary

suture was carried out. The suitability of the wound for primary suture was determined by the time the patient was admitted to hospital after injury, and also the magnitude and site of the wound itself.

Air transport of casualties is playing an increasing part in the treatment of battle casualties and our policy is to transport casualties after they have received first-aid treatment in forward areas, from small airstrips to hospitals where they can be treated with every facility and can be held after operation. We are still far short of this ideal arrangement, but small aircraft have been converted for this purpose. These casualties can be evacuated at a later date in transport aircraft or large air ambulances to special hospitals in base areas. Under these conditions the casualty would be moved only twice, and even then in relative comfort, so the old term "sending the casualty down the line" would not be heard.

After some experience we have found the following points to be very important.

1. Patients requiring further plastic surgery or brain surgery at special units are given first priority and are evacuated as soon as possible. Air sickness is not common amongst stretcher patients, but patients with facial injuries should have no splinting which would prevent free vomiting in an emergency.

2. To ensure comfort, all seriously ill patients should be loaded at the centre of balance of the aircraft, which is opposite the wing section. An early "take-off" and high altitudes are also essential for a smooth trip.

3. Fracture patients should be loaded in the lower stretchers so that the splints can be easily adjusted for comfort. To prevent pain a smooth trip is also essential for these patients.

4. Patients with chest wounds, particularly those in which a partial pneumothorax is present, must be evacuated at low altitudes, owing to the fact that any accumulation of gas increases in volume at higher altitudes and may be the cause of extreme distress and even death. This means that aircraft carrying patients with chest injuries from the north coast of New Guinea had to be routed to Townsville via Milne Bay to avoid the Owen Stanley Ranges.

5. Patients with head injuries should also be evacuated at low altitudes because many became cyanosed over the Owen Stanley Ranges and in spite of oxygen therapy some of them were very irritable. The exact reason for this is hard to explain, but it is probably due to failure of the respiratory centre to function normally as a result of the head injury.

6. Patients with abdominal wounds who have been operated on are not evacuated by air owing to the possibility of rapid distension of the gut at high altitudes. However, at times when evacuation by air has been necessary, the patients have travelled surprisingly well.

It is not difficult to foresee the time when men who have received first-aid treatment for severe injuries in the front line will be transported from small air strips immediately behind these lines to receive operative treatment within a few hours of injury at a major hospital hundreds of miles behind the fighting area, where the casualty can be retained indefinitely and given treatment under the best conditions. This would be a big contribution to the better treatment of battle casualties.

COLONEL F. J. CLARK (Australian Army Medical Corps): During my period of service in Australian Imperial Force hospitals receiving battle casualties, penicillin was not available. In spite of the excellence of the results quoted by previous speakers, I think that a note of caution should be sounded regarding too much reliance on the "wonder drugs" which are now available. It should always be borne in mind that both the method of wounding and the nature of the country in which wounding has occurred are very important factors in determining the subsequent behaviour of wounds, no matter what form of initial treatment is adopted. Wounds incurred in a dry, uncultivated desert, comparatively sterile country, are apt to behave, generally speaking, quite differently to similar wounds incurred in densely populated, cultivated and fertilized country. What happened in wounds from the Western Desert almost certainly would not happen in wounds from the banana groves of Damour. I therefore wish to plead that the present accepted method of initially treating wounds by the "open" technique should continue and that primary suture should have no place, no matter what drugs are available.

A previous speaker has mentioned the difficulties encountered in transporting certain types of wounded. It has early been apparent to me that certain types travelled very badly by road transport. Notable among these were those whose wounds were complicated by fracture of the humerus. Unless these fractures were at least partially immobilized by some form of plaster of Paris support the patients suffered considerably

and arrived at hospital in poor condition after ambulance journeys. It is impossible to render a casualty with a fractured humerus comfortable for transport in a horizontal position. The ordinary ambulance makes provision for this position only for the seriously wounded.

Another striking example is found in abdominal wounds. These patients have been wonderfully looked after by the forward surgical teams and have been kept in forward areas for a week or more before transport to hospital. Yet, when placed in the horizontal position for ambulance transport, they travel badly. Ultimately, improvised back supports were made, which enabled appropriate wounded to travel in something like Fowler's position on the lower stretchers of the ambulances with the upper stretchers removed. This procedure is a notable improvement for the patients already referred to, and also for those with wounds of the chest. No discussion of the modern transport of casualties would be complete without mention of air transport. Particularly during the Alamein battle, an Australian air ambulance unit rendered splendid service by transporting seriously wounded in this manner. This service was so rapid that it not infrequently happened that patients operated on in a casualty clearing station awoke from anæsthesia in hospital. Among the serious casualties so transported mention should be made of those with spinal injuries. By no other means can they be transported with so little discomfort and arrive in hospital in satisfactory condition.

It has been noted many times that, when a wounded soldier arrives in hospital, he wants three things: food, drink and, above all, sleep. It is to the everlasting credit of medical personnel working in the forward areas if the soldier arriving at hospital can be given all three quickly and safely, that is to say, without the requirement of further immediate surgical treatment. Owing to the excellence of the work of forward medical units in the Middle East this was possible in most instances. Their work was unsurpassed.

SURGEON-CAPTAIN LAMBERT ROGERS (Royal Naval Volunteer Reserve): I am glad that Colonel Clark has drawn attention to the environment in which wounding occurs, as affecting the type of wound and the result of treatment. I should also like to emphasize the importance of the nature of the missile which causes the wound. The missiles of this war travel at higher velocities than have ever hitherto been attained, and very often they are of comparatively light weight—for example, pieces of anti-personnel bombs. These are white hot when they strike, are surgically clean and travel at such a high velocity that they tend to cut cleanly through the tissues without carrying in pieces of uniform, webbing, equipment *et cetera*, as happened with heavier and slower travelling missiles in the past. The small, light, very fast-travelling fragment changes its momentum rapidly and soon comes to rest. The wound produced is quite frequently surgically clean and small pieces of metal are sometimes found inside the skull when it is submitted to X-ray examination, and the entering wounds by which these reached the brain are sometimes so inconspicuous as to be difficult to find in the scalp. I have seen some sixty cases in which small metallic fragments of this character were inside the brain; no operative treatment was undertaken and in only two instances did a subsequent inflammatory reaction give rise to a brain abscess, for which operation had to be performed.

The slow-travelling, leaden musket ball which killed Lord Nelson carried a piece of his epaulette and shreds of his uniform with it into the spinal canal. The fast-travelling missile today does not do this, and wounds are cleaner in consequence. While I do not wish for one minute to belittle the great boon of chemotherapy and penicillin, and the excellent results of modern treatment, the changing character of the wound itself, due to the missile which caused it, should be remembered and due allowance made for this.

MAJOR JOHN LOEWENTHAL (Australian Army Medical Corps): The apparatus described by Lieutenant-Colonel Renou is a modification of the standard army transfusion set. The object is to deliver, by continuous intramuscular infusion, a volume of 500 cubic centimetres of normal saline solution, in which is dissolved the twenty-four hour dose of penicillin. This requires the administration of 0·3 cubic centimetre per minute, which, with the ordinary glass dripper provided, amounts to six drops per minute. The standard Soluvac "giving set" is therefore modified by incorporating a fine hypodermic needle into the proximal end of the dripping chamber. This needle, of twenty-four gauge, delivers ninety drops per cubic centimetre, and the rate of flow can then be adjusted to thirty drops per minute—a rate capable of easy adjustment. The apparatus has been used in some seventy cases and about 300 flasks of penicillin have been delivered. Potency loss has been investigated, and neither the period at room temperature nor the rubber tubing used has caused any significant fall in potency. Some reactions have occurred at the infusion site. Their onset is variable, and in a few cases the infusion is continued for seven days into the same area without

discomfort. The present practice is to change the site of infusion every forty-eight hours. Certain technical difficulties associated with the nursing of patients and cleansing and sterilization of the apparatus have been met, but in a hospital in which a blood transfusion service is maintained, these have been easily overcome. It has not been possible to carry out a controlled experiment, but clinical results appear to be as effective and complete as with the three-hourly intermittent intramuscular administration. This method is considered to be useful, as it gives the patient undisturbed rest and freedom from multiple painful needle pricks.

AIR VICE-MARSHAL VICTOR HURLEY: The discussion has been most valuable because surgeons from almost every theatre of war have given their experiences. It is of particular interest to compare the procedures now used with those of the 1914-1918 war. It is clear that fundamental surgical principles—such as early and effective excision of wounds, resuscitation measures and immobilization, still hold good, but that variations in the methods of their application are required to deal with altered conditions of warfare and also to conform to military operational requirements. The present war has largely been a war of movement, and the static conditions of trench warfare in the last war have not been encountered this time, except in some theatres, such as in Italy, and then only for certain periods. Under the trench warfare conditions which obtained on the Western Front in France and Flanders in the autumn and winter of 1916 and 1917, the numbers of casualties were greater, the wounded could not be brought so quickly for surgical treatment, and there was a high degree of contamination of wounds. These conditions were quite different, for example, from those of the Western Desert.

The fundamental necessity for adequate and early excision of wounds has been universally accepted by operating surgeons from 1917 onwards in the last war, who frequently met and exchanged their experiences as the speakers have done today. In the intervening years, however, and in the early part of this war, it seemed that this lesson had to be learnt again, and in the hard way, by personal experience of the dangers incurred when effective excision has not been performed and the disasters which follow if such wounds are closed by injudicious packing or plugging of the wounds or by early suture.

The early endeavours of surgeons to secure wounds sufficiently free of infective organisms to permit of their safe closure were along the lines of local wound applications, such as by the use of Carrel-Dakin methods, "BIPP", flavines *et cetera*; but the answer came from an entirely different approach, in that the beneficial action of sulphonamides and of penicillin depends on their presence in sufficient concentration in the circulating body fluids.

Some of the more important factors which are responsible for the greatly improved results of wound treatment in this war are: earlier and more effective surgical treatment; the greater use and readier availability of transfusions of blood and serum, as well as resuscitation methods generally; the introduction of sulphonamides and penicillin; and the use of air transport by which wounded may be rapidly transported to places where all necessary staff and equipment are available, or alternatively these can be quickly flown to the forward areas.

H. R. G. POATE: It seems appropriate that I should conclude this very interesting discussion so ably opened by Colonel Renou as one who served in the active areas during the Great War, has followed the old soldiers in the Repatriation hospital ever since, and now in this war has been concerned in the final phases of war injuries as seen at the home base hospitals.

Sepsis has always been the bugbear of the surgeon, and Carrel-Dakin methods were the first to show promising results in the Great War. In 1917 I happened to be with a British casualty clearing station when the first supplies of acriflavine were sent over by Browning, and was impressed with results of its use in lavage of purulent wounds. Later, proflavine came on the scene and was more satisfactory. It was unfortunate that these two acridines had such an acid reaction with pH 2, as this largely accounted for the unfavourable results. During this war I have had the good fortune to be closely associated with Dr. Adrien Albert, who has been responsible for the introduction of the neutral acridines (pH 6), of which 5-amino acridine ("Monacrin") has been so successful in the treatment of established sepsis, and 2-7 diamino-acridine in the treatment of cerebral wounds. "Monacrin" has the virtue of being stainless and of being much more potent against staphylococci than the old acridines. Our greatest success was in clearing up the established sepsis in compound fractures returned from Alamein, and from the early days in New Guinea, and articles by Major Harley Turnbull in THE AUSTRALIAN AND NEW ZEALAND JOURNAL OF SURGERY and by myself in *The Medical Journal of Australia* and *The Lancet* detail the technique and results. The free supply of sulphanilamide in forward areas and the exhibition of

the newer sulphonamides have helped greatly in preventing sepsis, and this local effect in wounds is enhanced by using 1% "Monacrin" with sulphanilamide. However, in the past twelve months or so all this work has been overshadowed by the advent of penicillin and its manufacture in Australia in such quantities as to meet army and civilian needs. This has been one of the greatest Australian achievements and is due to the energy and untiring perseverance of Major Bazeley. However, despite penicillin, some wounds still do reach the stage of chronic or established sepsis, and I would ask surgeons to remember the great value of the newer acridines for treatment or, if they are unavailable, then to use neutralized proflavine, as suggested by Albert. It seems that we can control most streptococcal infections and they are no longer the dread of the surgeon as they were earlier in this war. The staphylococci and the Gram-negative organisms are the nuisances. As regards the former, we are now using some supraflavine—the latest of Albert's acridines—which is sixteen times more efficacious against staphylococci than is proflavine, and it promises well. As regards the pyocyaneus group, we are trying phenoxytol with encouraging results, and Albert is working out different forms of this and allied substances in the attempt to find a chemical antiseptic potent against the Gram-negative organisms as a whole, and a very promising field of work is being opened up. I think our medical directorate has just pride in the magnificent work achieved by our surgeons during this war, and we feel that the care of the wounded in the war against Japan is now in the extraordinarily capable hands of experienced surgical teams.

PENICILLIN TREATMENT OF EXPERIMENTAL OSTEOMYELITIS IN RABBITS.[1]

By F. P. O. NAGLER,
From the Walter and Eliza Hall Institute, Melbourne.

OSTEOMYELITIS and its treatment in laboratory animals have been studied for a considerable time. Success in establishing an infection comparable with that occurring in man has been reported by a number of authors. With the advent of penicillin therapy for staphylococcal infections it has become of special interest to determine how much can be expected from the drug alone and what type of associated surgical treatment is needed at various stages of the disease. The work described below represents an attempt to study the effectiveness of penicillin alone in the treatment of experimental osteomyelitis in rabbits.

MATERIALS AND METHOD.

One strain of *Staphylococcus aureus*, "Radford", was used throughout the experiments. It was recently isolated from a human case of acute osteomyelitis by Dr. Hilda Gardner at the Royal Melbourne Hospital. It was selected from a number of strains of *Staphylococcus aureus*, which produced osteomyelitis in rabbits, because of its low toxicity and tendency to remain localized. The growth of this strain was completely inhibited in broth by 0·1 Oxford unit of penicillin per millilitre.

Penicillin was obtained from the Commonwealth Serum Laboratories, Melbourne, as the dried calcium salt. Before use it was made up as a suspension in peanut oil and beeswax, as described by Romansky and Rittman (1944).

Rabbits of mixed breed from our own stock were used. Their weight was between 600 and 800 grammes.

The method of infecting the rabbits, described by Scheman *et alii* (1941), was followed except for slight alterations. A preliminary injection of 0·25 millilitre of a 5% watery solution of sodium morrhuate was made into the medial side of the proximal epiphysis of the right tibia with a short 23 gauge needle. This solution was freshly prepared and filtered through a Seitz E.K. disk. It was found necessary to inject the solution very slowly, as a number of animals died in convulsions immediately after a rapid inoculation. Rabbits with a weight of more than 800 grammes were found very hard to inject by this method, as the calcification of their epiphysis was too far advanced.

The *Staphylococcus aureus* culture was inoculated into the same site one hour after the sodium morrhuate. The strain had been kept in stock on "Bovril" agar and was inoculated into nutrient broth twenty-four hours before the rabbits were infected. It was finally diluted to one in 100 in broth, 0·25 millilitre of this suspension being injected into each animal.

In experiment C a single injection of a watery solution of penicillin was given immediately after the infection, with the object of protecting the animal against any immediate entry of staphylococci into the circulation and restricting infection to the site of inoculation. It was given intramuscularly in a dose of one Oxford unit per gramme of animal.

[1] Accepted for publication on October 11, 1945.

Treatment with penicillin was begun in experiment B1 six days after injection of the *Staphylococcus aureus*. It was given twice daily for three weeks intramuscularly into the left thigh in the form of a suspension in peanut oil containing 6% white beeswax. This suspension was prepared by heating the peanut oil-beeswax to 80° C., the dry calcium penicillin powder then being added at that temperature and shaken with glass beads. A single dose for each animal consisted of 0·25 millilitre of oily suspension containing 2,500 Oxford units. The total amount given in three weeks' treatment was, therefore, 100,000 units per animal.

In experiment C1 the same treatment was started forty-eight hours after the infection was initiated.

The diagnosis of osteomyelitis in rabbits had mainly to be based on post-mortem findings. The surviving animals were killed at the end of the sixth week in experiments B and C. The tibiæ of both legs of each animal were removed and freed from flesh and soft tissues. The alteration in the bone structure in form of absorption, death of original bone, sequestration and production of new bone was thus easily recognizable. This method of diagnosis was adopted because it was found that X-ray examination and clinical diagnosis during life were not entirely reliable.

FIGURE I. Three rabbit tibiæ, showing osteomyelitis after injection with *Staphylococcus aureus*, in comparison with one normal tibia.

A few experiments showed that the beeswax-peanut oil suspensions of penicillin gave in rabbits the same prolongation of the period of effective blood level that had been observed by Romansky and Rittman in human beings. Six hours after an intramuscular injection of 10 Oxford units per gramme of animal the average penicillin level was 0·25 Oxford unit per millilitre of blood, whereas the last measureable amount, 0·03 Oxford unit per millilitre of blood, was detected at eight hours after the injection.

RESULTS.

Experiment A.

A preliminary experiment was carried out to obtain information about the course of the infection with strain "Radford" in rabbits. Of a group of 14 animals infected, one died of a generalized infection before the end of the third week and two others succumbed between the fourth and fifth weeks. Ten of the remaining animals were killed eight weeks after the inoculation and their tibiæ were removed. In Figure I three of these bones are shown in comparison with a normal tibia. Only one animal of this group failed to develop osteomyelitis. Another animal developed a secondary osteomyelitis of the corresponding femur. It was killed six months after the inoculation. The femur was opened up and revealed a nearly complete absorption of the original bone, of which only a paper-thin layer remained.

Experiment B.

In group B1 of this experiment, in which penicillin treatment was delayed for six days, four animals died of a generalized staphylococcal infection during the last week of observation. From two of these animals living staphylococci were recovered

from deep tibial abscesses and were found to have the same sensitivity to penicillin as the original strain "Radford". Of the surviving animals which were killed after six weeks, only one showed no trace of osteomyelitis. In two rabbits signs of healed osteolytic processes were found, indicated by roughness of the bone surface, spongy appearance of the bone and formation of small exostoses. No active tibial abscesses were found, nor could the staphylococcus strain be recovered from these animals. In four rabbits osteomyelitis of medium severity was observed. It was confined to the

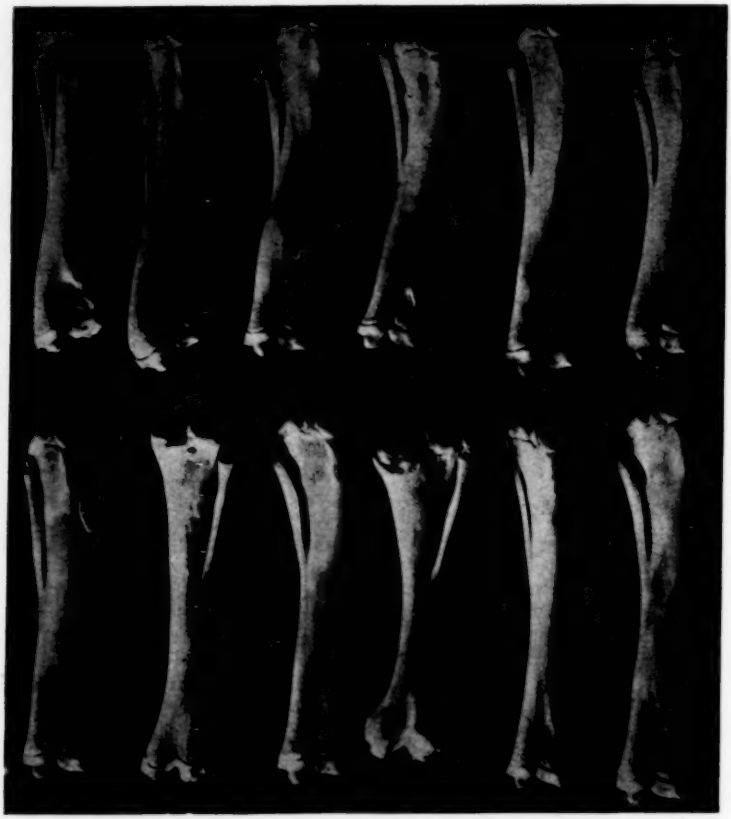

FIGURE II. Tibiæ of group C1 injected with *Staphylococcus aureus* and treated with penicillin over a period of three weeks, commencing forty-eight hours after the infection.

proximal epiphysis of the tibia and had produced small sequestra as well as new spongy bone. Living staphylococci were recovered from three of these cases. Five animals of this group had a severe osteomyelitis with extensive sequestration, which in two involved the whole shaft of the bone. In another tibia the whole of the epiphysis had become a large sequestrum surrounded by a dome of new bone.

A group of twelve control animals (group B2) was infected in the same way as in group B1 but was not treated; seven of these rabbits died during the time of observation. Eleven of this group developed a severe osteomyelitis, and in only one animal had the infection remained localized and had healed at the time of the post-mortem examination. Several animals showed secondary osteomyelitis of the ribs and sternum. In another animal osteomyelitis in the metatarsal bones of the opposite leg occurred.

Experiment C.

Treatment in group C1 of this experiment was delayed for only forty-eight hours. Two animals died during the time of observation. The tibia of one showed typical sequestration at the time of death, which was due to lobar pneumonia. Death of the second animal occurred immediately after the last penicillin-peanut oil injection. The animal died in a state of shock and the post-mortem examination revealed congestion of the liver, slightly enlarged kidneys and dilatation of the heart. No emphysema of

FIGURE III. Tibiæ of group C2 injected with *Staphylococcus aureus* but not treated.

the lungs could be seen. The infected tibia presented no osteomyelitis and recovery of the *Staphylococcus aureus* from the site of infection failed. The microscopic sections showed a subacute nephritis and multiple acute bleedings into the parenchyma of the liver. Four of the surviving animals which were killed at the end of the experiment showed no signs of osteomyelitis. From none of those could the *Staphylococcus aureus* be recovered. Four other animals showed traces of healed localized osteolytic processes, similar to those in the corresponding division of group B1. Three further animals had osteomyelitis of medium extent, including two with a unilateral deformation of the distal tibia condylus, resembling rickets. The tibia in only one animal of this group showed signs of a past severe osteomyelitis which had healed at the time of the

post-mortem examination. No abscess was found and no living *Staphylococcus aureus* could be isolated from this animal. The tibiæ from group C1 are shown in Figure II, the heaviest damage in each bone being turned toward the camera.

In control group C2, 11 rabbits were infected in the same way as in group C1, but no treatment was given. Seven of these animals died during the period of observation, death being due to severe osteomyelitis with a secondary infection of other organs, particularly the kidneys. Two of the animals which survived until the end of the experiment had also severe osteomyelitis and lesions in other organs as well. The other two surviving animals in this group showed minor signs of a past osteolytic process in the tibia from which no living *Staphylococcus aureus* could be recovered. The tibiæ of group C2 are shown in Figure III.

Table I gives the results of the treatment experiments B1 and C1 as well as a control group D. This group D is a composite of control groups A, B2 and C2, the results of which were very similar. The figures in the last column of this table indicate the average severity of the osteomyelitis in each group, taking the severe cases as 3, the medium as 2, the mild as 1, and no lesion as 0.

TABLE I.

Delayed Treatment of Osteomyelitis in Rabbits with Penicillin.

Group Number.	Number of Animals.	Penicillin. Total Doses per Animal. Oxford Units.	Interval between Infection and Treatment. Days.	Number of Deaths.	Number of Animals with Osteomyelitis.				Average Severity of Osteomyelitis.
					Severe.	Medium.	Mild.	None.	
B1	12	100,000	6	4	5	4	2	1	2·1
C1	12	100,000	2	2[1]	1	3	4	4	1·1
Controls D	37	—	—	17	30	3	3	1	2·7

[1] Including one accidental death.

DISCUSSION.

Our investigations of penicillin therapy in osteomyelitis unfortunately could not be pursued further. No definite conclusion can be drawn from the results obtained. However, it has been found that osteomyelitis resembling that in human beings can easily be produced in nearly 100% of the laboratory animals by Scheman's method, when a suitable strain of *Staphylococcus aureus* is used. This provides a useful means for studying penicillin therapy in this disease.

Penicillin therapy under the conditions of the experiments failed to cure the majority of cases of experimental osteomyelitis in rabbits. The staphylococci which retained their sensitivity to penicillin were able to persist in the lesions through the three weeks' period of treatment. This shows that penicillin as administered in these experiments is unable to sterilize all osteomyelitis lesions when not assisted by surgery.

It must remain open whether better results might not have been obtained with other modes of administration and larger dosage. However, the amount used corresponds approximately to a daily administration of 500,000 Oxford units to a 70-kilogram adult patient, so that it seems reasonable to look for other reasons for the relative failure of penicillin treatment. The experimental method used to produce the osteomyelitis includes the production of a region of impaired circulation and tissue damage within which primary multiplication of the staphylococci can take place. In such circumstances penicillin could not be expected to do more than prevent to a greater or less extent damage to bone in regions beyond those infected at the time treatment was initiated. As experiment C1 indicates, far better results may be expected if treatment is begun while the site of infection is still of limited extent.

SUMMARY.

Experimental osteomyelitis resembling that in human beings can be produced in nearly 100% of rabbits by infection with a suitable strain of *Staphylococcus aureus* according to the method of Scheman, Janot and Lewin.

Penicillin given in the form of a suspension in peanut oil and beeswax has a beneficial effect on acute osteomyelitis in rabbits when given within forty-eight hours after the infection, but fails to prevent extension of the disease in all cases.

Treatment with penicillin delayed for six days had no significant effect on experimental acute osteomyelitis in rabbits.

ACKNOWLEDGEMENTS.

I am greatly indebted to Dr. A. W. Turner, of the Council for Scientific and Industrial Research, for the microscopic sections; to Dr. B. Wood, of the Royal Melbourne Hospital, for carrying out the X-ray examinations; and to Mr. N. Southern, of the Council for Scientific and Industrial Research, for preparing the photographs.

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RESECTION OF PULMONARY TISSUE IN TUBERCULOSIS.[1]

By Douglas Robb,
Auckland.

Removal of diseased lung tissue in tuberculosis has become possible through recent technical improvements. These include the abandonment of the tourniquet in favour of dissection of the hilum and the individual treatment of its elements, and refinements in the technique of anæsthesia.

Already a considerable literature has appeared, and large groups of cases—over 100 in some instances—have been recorded. Perhaps the method has already been used too freely, but there is a remarkable and praiseworthy moderation in what has been written. Difficulties and limitations are obvious enough, and there is a serious search for definition of indications and contraindications.

It is scarcely necessary to emphasize the general or constitutional nature of the disease, and that its anatomical distribution must always be or have been bilateral, however circumscribed the grosser lesions. Is it possible, even with hilum dissection, to remove the diseased tissue completely? Even if so, will not the added mechanical and functional strain prejudice the remaining lobes? Will the space remaining after lobectomy or pneumonectomy diminish and heal, or will it remain as an empyema cavity, discharging tuberculous or non-tuberculous pus? Will the physiological result after resection be better or worse than after a thoracoplasty of the modern, highly selective type? These and other queries arise at once.

The present series of four cases is presented as illustrating both the difficulties and the possibilities of the method, though there are as yet no long-term results to record. Our attitude is one of caution in accepting a patient for resection, without denying it to a patient otherwise in a hopeless position who might be saved by it. The operative difficulties may prove to be great in any projected case, and we feel obliged to take greater care in certain details, particularly in the closure of the bronchus, than we have done in the past.

Case Records.

Case I. Right Lower Lobectomy for Pulmonary Tuberculosis.

Miss D.R., aged nineteen years, twelve months and eight months before operation had had hæmoptyses. X-ray examination revealed atelectasis of the right lower lobe, the remaining parts of the lung fields being clear. As time went on the right lower lobe contracted further, and a cavity with a fluid level appeared in it. Bronchoscopically there was neither obstruction nor bronchial tuberculosis. Iodized oil would enter only the first dorsal branch of the right lower lobe bronchus. It was argued that any collapse therapy—pneumothorax, phrenic palsy or thoracoplasty—could not bring about further collapse of the diseased area, and would sacrifice only good lung. Resection was therefore planned.

On December 11, 1944, right lower lobectomy was carried out by hilar dissection. One thick silk ligature was applied to the bronchus without other treatment to the mucosa. There was a remarkable absence of adhesions over the lobe, which was collapsed and almost airless save for the cavity, which was four centimetres in diameter. The tissues in the hilum of the lobe were similarly very healthy, and no glands were seen. The operation was borne well and convalescence was uneventful, the wound being soundly healed. The bronchial stump must have remained closed, for no fistula nor empyema developed.

Seven months after operation neither cough nor sputum was present and the general condition was good. Recent infiltration of both apical regions had just been found radiologically (previously not seen), and bed rest was therefore resumed.

Case II. Left Pneumonectomy for Tuberculosis Complicated by Bronchial Tuberculosis and Stenosis.

Mr. A.A., aged twenty-seven years, gave a history that four years before operation a persistent cough developed after a cold. Pain in the chest came two years later, when X-ray examination of the chest revealed nothing serious. The patient remained at work with a persistent dry cough until fifteen months before operation, when a

[1] Accepted for publication on August 20, 1945.

heavy sputum developed. This was found to contain tubercle bacilli. On bronchoscopic examination readily bleeding granulation tissue was seen in the left main bronchus; iodized oil showed partial occlusion of the bronchus. These areas were treated with silver nitrate for a period. One month before operation the left main bronchus above the level of the upper lobe bronchus was much narrowed, preventing the instrument passing further down. Copious, thick, creamy pus welled up through the stricture. Radiologically changes were definite in the left lung, the right being clear.

On March 21, 1945, left pneumonectomy was performed under intratracheal cyclopropane and oxygen anæsthesia, after preliminary pneumothorax and physiotherapy to the costal and diaphragmatic function on the right side. There was some delay separating adhesions, but the hilum was not indurated. One thick silk ligature was tied round the bronchus. The mucosa was carbolized, and a second ligature was tied round. Finally the distal extremity was transfixed and tied with a third silk ligature. The mucosa at the point of section and for some distance above was tuberculous.

For over four months this patient's course has been favourable. He was kept in bed for three months. The fluid effusion remained sterile and was aspirated twice. The left bronchus has so far remained closed, but is seen to contain tuberculous granulation tissue up to the carina. The stump has been aspirated and painted with 30% silver nitrate on several occasions. There is a little early morning sputum, which contains tubercle bacilli. He feels well and has put on eight pounds in weight. The right lung field is clear radiologically, its function being greatly benefited in the post-operative period by the breathing exercises.

Case III. Left Pneumonectomy for Tuberculosis Complicated by Bronchial Tuberculosis and Stenosis.

Miss I.S., aged twenty-six years, gave a history that two and a half years before operation an X-ray examination of the chest made for military purposes aroused suspicions. Slight hæmoptysis occurred. The sputum was not at first positive. A respiratory wheeze in the left side of the chest was marked from the early stages. Later an increase in the radiological changes in the left lung took place, with retention of secretions and high fever. Bronchoscopically the mucosa of the left main bronchus was pink and thickened almost up to the carina. Beyond the first centimetre (where ring markings were not visible) the lumen diminished rather abruptly, with a bulge on the lateral wall. Beyond the bulge the upper lobe bronchus opening was not seen, and the lumen became an irregular slit. Much pus welled up through the stricture.

On April 11, 1945, left pneumonectomy was performed under intratracheal cyclopropane and oxygen anæsthesia, after preliminary pneumothorax and physiotherapy. Adhesions were not marked, though a dense adhesion at the base required resection of a piece of diaphragm the size of half-a-crown. The hilum was healthy save for some peribronchial thickening. Three thick silk ligatures were tied round the bronchus without special treatment to the mucosa. The operation was a severe one, but the immediate post-operative course was satisfactory. Aspiration of the fluid effusion, which remained sterile, was carried out twice.

No surgical complications occurred, but a persistent fever could not be elucidated. The right lung field remained clear. Three months after operation a staphylococcal infection of the fluid exudate was recognized, and soon after it was apparent the bronchus had opened. At present a bronchopleural fistula is present, tube drainage of the infected left hemithorax is being carried out, the right lung is clear, and the general condition is not very good but improving.

Case IV. Left Pneumonectomy for Pulmonary Tuberculosis with Bronchial Tuberculosis and Stenosis.

Mrs. H.B., aged thirty-two years, was admitted to hospital four months before operation with a diagnosis of primary atypical pneumonia. She had had a barking cough for twelve months, but it had become worse, and she had felt ill for two weeks. The sputum was found to contain tubercle bacilli. The X-ray film showed atelectasis in the left upper zone. Much coughing and wheezing were present. Bronchoscopically, five weeks before operation, the left main bronchus was seen to have thickened red mucosa up to the carina. There were areas of granulation tissue and ulcers on the main carina and on that of the left upper lobe bronchus. Distortion of the tree allowed a better view than usual into the left upper lobe bronchus, which discharged much secretion. The main bronchus then curved backwards, preventing further passage of the instrument.

Operation was performed on May 23, 1945, left pneumonectomy under intratracheal cyclopropane and oxygen anæsthesia, after a previous phrenic crush and physiotherapy, being performed. Adhesions were fairly troublesome, the division of some apical adhesions opening caseous spots in the lung tissue. The bronchus was closed by two thick silk ligatures, its mucosa was carbolized, and a rather unsatisfactory distal

mattress suture was applied. The operation was felt by the patient, who was a sick woman, but she came through the immediate post-operative period in good heart.

Moist sounds were heard in the right upper zone and the first film after the operation showed a doubtful infiltration there. There had been no difficulty with sputum during the operation nor with expectoration afterwards. On the twelfth post-operative day the effusion was found to be infected with staphylococci, and soon afterwards a bronchial fistula was evident. From then the patient rapidly went down hill and died on the twenty-second day.

On post-mortem examination considerable peribronchial tuberculous infiltration, believed to be recent, that is, post-operational, was found in the right lung. The left pleural cavity was lined by a pyogenic membrane. The ligatures seemed all to be securely in place, and the pulmonary artery and veins, viewed from inside the lumen, were firmly ligated, the corrugated ends being devoid of clot. The end of the left bronchus (which was three-quarters of an inch long) was round like the bottom of a test tube, but a probe could be pushed through narrow holes in two places. On naked eye examination the mucosa was not grossly affected. There were tuberculous ulcers in the lower part of the ileum, caecum and ascending colon. In view of the relatively good state of the bronchial stump it is possible that the primary misfortune was staphylococcal infection of the exudate through exposure of air passages at the operation when adhesions were being separated. The pleural infection then weakened the security of the bronchial closure.

Brief Comments on the Four Cases.

All save the patient in Case I were seriously ill and, according to local experience with tuberculous bronchial stenosis, had a poor outlook. They were likely to decline rapidly. Case IV illustrates the inevitable hazards—post-operative spread to the good lung, to say nothing of tuberculosis elsewhere in bowel *et cetera*. Cases III and IV illustrate early and later development of bronchial fistula, a serious but not necessarily fatal complication. Late development of fistula may yet occur in both Cases I and II, and in Case II tuberculosis is known to be present in the stump four months after operation. Only in Case I could the patient be regarded as ideal for operation, the other three being known to have tuberculosis of the main bronchus right up to the carina. Division therefore had to be made through unhealthy tissue.

Encouragements, however, are not lacking. There was no immediate operative mortality and three out of four have a prospect of surviving. Better treatment of the bronchus promises fewer complications in the future. (See *Post Scriptum*.)

Indications for Resection.

The indications for resection have not yet been clarified, nor will considered judgement be possible perhaps for some years. Individual consideration of cases is necessary. In general one can say that resection does not come up for consideration until after the usual methods of medical treatment, pneumothorax, phrenic palsy and thoracoplasty have either been tried and failed or are thought to be unpromising. In such a situation it is a good thing to have another procedure to turn to.

Two main types in which resection is applicable are exemplified in this short series: (i) tuberculous bronchitis, particularly with stenosis and retention of secretions (Cases II, III, and IV); (ii) cavities with or without adjacent atelectasis in lower lobe or in the hilar region (Case I).

Authors vary in their lists of indications and contraindications, and a study of the literature will doubtless be made before resection is decided upon in any given case (see, for example, the whole numbers of *Journal of Thoracic Surgery*, February, 1945, xiv, and *Diseases of the Chest*, January-February, 1945). F. S. Dolley, of Los Angeles, and Overholt and Wilson may be quoted.

Dolley writes:

> . . . Lung resection is likely to be indicated:
>
> (1) If the disease is largely bronchiectatic and the tuberculosis not particularly active.
>
> (2) Cavities at mediastinum, hilum or lower lobe where prognosis for closure by other means is far from good.
>
> (3) Tension cavities under conditions already mentioned.
>
> (4) After thoracoplasty where clear evidence that cavity closure is not to occur except by extrapleural pack or external drainage, and then only after careful consideration of operative risks and probably comparative results.
>
> (5) Progressive stenosis of main or secondary bronchus.
>
> It is self-evident that none of these is a uniform indication for pulmonary resection, yet it is a source of great comfort to know that such a recourse exists. In the meantime, during these developmental years, caution is the keyword in the selection of cases.

Overholt and Wilson write:

> Although it may be unwise to outline specific indications for an operation which has evoked so much controversy, our experiences prompt us to consider resection as the treatment of choice for the following types of disease:
>
> 1. In preference to thoracoplasty in cases with active parenchymal disease complicated by bronchial stenosis.
>
> 2. Extensive basal tuberculosis with or without associated bronchiectasis.
>
> 3. In unilateral disease that has failed to respond to a pneumothorax with apparently adequate collapse.
>
> 4. In unilateral disease that has failed to respond to an adequate thoracoplasty.
>
> 5. In preference to cavernostomy in the treatment of tension cavities in unilobar or extensive unilateral disease.
>
> 6. In extensive unilobar disease with dense opacities and little evidence of fibrosis and retraction.
>
> 7. Progressive unilobar or unilateral tuberculosis in the teen-age group.
>
> 8. Tuberculoma.

Operative Technique—Closure of the Bronchus.

Perhaps the most important procedure in the operation is the closure of the bronchus. The development of a bronchopleural fistula at an early or a late stage may not prove fatal, but it always prolongs invalidity and pain and suffering.

With the best will and skill in the world, circumstances may weigh against success. The bronchial walls are stiff and resilient, and often infected at the point of division. The closure comes usually late in the operation, which may have already been prolonged and have placed a severe strain on patient and operating team. It seems desirable at all costs to complete the job and get the patient back to bed. Hence, the simplest methods of closure—ligature with or without dissection or carbolization or cauterization of the mucosa—may be not only permissible, but the only procedures possible. That they may succeed is shown in this series, and also in two other personal pneumonectomies (for carcinoma and bronchiectasis).

Much has been done and written on the technique of closure of the bronchus. (Rienhoff *et alii*, Jones, Overholt and Wilson, page 46). Rienhoff believes that the cut end beyond the occluding sutures generates the granulation tissue leading to the final sealing, and believes strongly in a pleural flap. He thinks the mattress sutures should be air-tight, but not tight enough to strangulate tissue.

I propose to use the following technique, following particularly Overholt and Jones, where possible in the future, for all lobectomies and pneumonectomies, whether for tuberculosis, cancer or other disease.

The bronchus is divided with a knife between curved clamps. Sutures of stainless steel wire (Jones) or silk (Overholt) on atraumatic (intestinal) needles are passed through the bronchus from front to back three millimetres proximal to the clamp on the stump. Eight sutures are required for a main bronchus. The clamp is loosened and removed, and each suture is tied over the cut end, an airtight closure being made. The bronchial artery may require a special silk ligature at the end of the stump after the clamp is removed and the wires tied. Sulphanilamide crystals are sprinkled over stump and raw surface, and flaps of pleura (fashioned from the hilum of the lung at the beginning of the dissection) are sutured over the stump, a gap being left for drainage above and below.

The advantages of this method include the following. The single clamp "uses" a short length only of bronchus, and may be applied high up near the bifurcation. This may be essential in tuberculosis and malignant disease. The blood supply of the stump is retained to a maximum degree, and the sutures may be applied with very little trauma. The sutures cause a minimum reaction in infected or potentially infected tissue and remain *in situ* for a long time.

Using variations in this technique, both Jones and Overholt and Wilson have amassed substantial series of cases in which the development of a bronchial fistula is almost eliminated even in tuberculous cases.

Other points in operative technique may be briefly mentioned. Our patients have been greatly helped by pre-operative and post-operative physiotherapy; this has enabled them to use upper or lower ribs or diaphragm to ventilate fully all parts of the remaining lung. We have been slow to aspirate the post-operative fluid effusion unless embarrassment or displacement of mediastinum is marked. If it remains sterile, as it did after three of our pneumonectomies, the discomforts of the post-operative period are remarkably slight.

Acknowledgements.

These patients have all been treated at the Green Lane (Auckland) Hospital Thoracic Unit. Dr. C. McDowell and Dr. J. R. Hinds have been in charge on the medical side and have done the bronchoscopies. Dr. Alexandra Warnock has given the anæsthetics. Without the essential help at all stages of these and other individuals the management described would have been impossible.

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Post Scriptum.

Further Progress Notes.

CASE I. The infiltration mentioned rapidly spread and the patient died twelve months after operation with widespread pulmonary disease.

CASE II. Thirteen months after operation this man remains apparently cured. No painting of the bronchial stump has been necessary for some months. When last seen it took the form of a shallow blind pouch lined with healthy mucosa. There is no sputum.

CASE III. This patient died four months after operation with tuberculosis in the right lung and throughout the peritoneum.

Additional Case Briefly Described.

Mrs. W., aged fifty-two years, had a three-year history of bronchiectasis affecting the left lower lobe and lingula. The disease was gross, sputum being negative for tubercle bacilli. Resection of lingula and left lower lobe was carried out; this confirmed the diagnosis but revealed in addition a spotty caseation between the bronchi, particularly in the lingula. This proved on section to be tuberculous, and the sputum subsequently contained tubercle bacilli. She has done well during the five months since operation, and seems to be overcoming an infiltration which appeared after operation in the left upper lobe.

Closure of Bronchus.

Since the article was written the technique described has been used regularly in all cases of lobectomy and pneumonectomy, with much satisfaction. Silk sutures have been used, the wire being unobtainable. The local use of sulphathiazole crystals to the stump in bronchiectatic cases has been replaced by penicillin with good results.

Summary and Conclusions.

Three cases of pneumonectomy and two of lobectomy for pulmonary tuberculosis are described. There was no operative mortality. Three of the patients died of tuberculosis elsewhere in lung or abdomen, three weeks, four months and twelve months after operation. One is doing well five months later, and one is apparently cured thirteen months later. All were unfavourable cases.

The general position of resection in tuberculosis is discussed, and technical points, chiefly in the matter of bronchial closure, are mentioned.

PSOAS ABSCESS FOLLOWING ACUTE APPENDICITIS.[1]

By JOHN DEVINE,
Melbourne.

MANY and varied are the types of abscesses found associated with acute appendicitis. The following case is presented because a long-standing case of acute appendicitis was associated with a non-tuberculous psoas abscess.

An Albanian farmer, aged thirty-one years, stated that he had been quite well until fourteen days before. He then developed constant epigastric pain followed by nausea, anorexia and frequent vomiting. The pain did not radiate anywhere, but was very severe and kept him awake at night. His bowels were regular and opened daily without aperients, and he had no urinary symptoms. He had struggled to harvest a crop, but finally collapsed in great misery.

When first seen he appeared to be very ill, dehydrated, shivering, and complaining that in the last few days he had had shivers and sweats. He had a dirty brown tongue and his breath was characteristic of an abdominal condition. His chest and heart were normal on examination; his abdomen was rigid and tender in the right iliac fossa, and the tenderness extended high up on the right side under the right costal margin. No abnormality was detected on rectal examination.

His pulse rate was 100 in the minute and his temperature just over 100° F. Operation was performed immediately, and under "open" anæsthesia a split-muscle incision in the right iliac fossa revealed a tense and hard psoas muscle. This was noted and then the caecum was found to be completely undescended and in position under the liver; the appendix was retrocaecal and firmly attached to the posterior abdominal wall and so twisted on the caecum as to be in the neighbourhood of the right psoas muscle. The incision was enlarged upwards and the ileo-caecal junction and hepatic flexure were mobilized by cutting the peritoneum lateral to them and stripping them

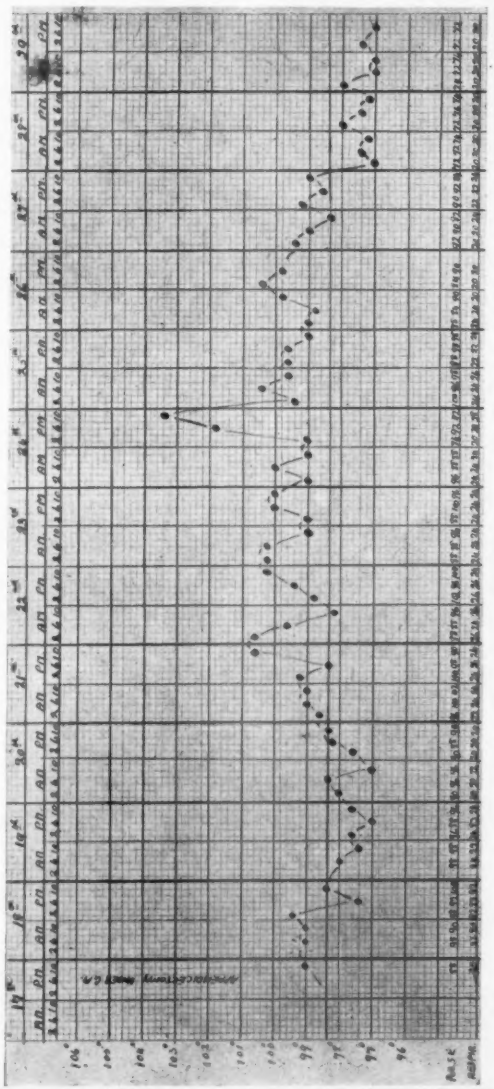

FIGURE I.

[1] Accepted for publication on November 19, 1945.

medially off the posterior abdominal wall. A very diseased appendix, about two inches long, was then brought into view. It was surrounded by lymph, had thickened, œdematous walls, and in places appeared to be almost gangrenous. The tip had apparently ruptured back into the caecum. Thus, when it was removed, both ends had to be invaginated with pursestring sutures. When this had been accomplished it was decided to drain the bare area left by the mobilization required, and a stab wound was made in the right loin and through it a long Spencer-Wells forceps was introduced. A gush of greenish pus then exuded. Pressure on the psoas muscle (which had been previously noted to be tense) forced out further pus and, with milking of the psoas muscle sheath, emptied it of pus through the loin stab incision. A tube was introduced and the abdomen was sewn up in the usual way. This whole procedure took nearly two hours.

FIGURE II.

In the after-treatment the patient was given an immediate intravenous saline infusion because of his dehydration; he received three litres of saline solution in the first fourteen hours and two grains of sulphadiazine every four hours. Morphine was given in doses of one-sixth of a grain every four hours.

A smear and culture of the exudate prepared by the pathologist (Dr. Brenan) showed a *Streptococcus viridans*, a diplostreptococcus and an unidentified Gram-negative bacillus. This examination of the discharge was repeated four days later with a similar result.

Four days after operation the patient's abdomen began to become very distended and his general condition was not as good as it had been, and he was having profuse skin actions. He vomited brown, offensive fluid, seventy-two ounces in twelve hours. A Rehfus tube was passed and continuous suction was applied. In view of the bacteriological findings and the lack of any diminution in the green drainage from the tube with sulphonamides, penicillin was then commenced, 20,000 units being given every three hours, and 600,000 units in all. On the seventh day an enema was given with good result; intravenous therapy was discontinued and the tube was removed because drainage was then much less. From this time on the patient proceeded to recover without further incident. The temperature chart is shown in Figure I.

Ten days after he had come out of hospital a plain skiagram of his chest revealed no abnormality, and a barium enema was given and the short caecum shown in the illustration was found. A plain skiagram of the abdomen revealed no change in density of either psoas muscle or changes in the lumbar vertebræ (see Figure II).

This case is reported because of its interest from the point of view of the unusual complication of appendicitis, and because of the technical difficulties that were encountered in actually reaching the diseased appendix.

ADVANCED CARDIOSPASM: REPORT OF A CASE TREATED BY CARDIOPLASTY.[1]

By Douglas Robb and Eric I. A. Macdonald,
Auckland.

Mr. K.W.S., forty-seven years, first remembered difficulty in swallowing at eight years while he was at a picnic and could neither swallow nor vomit some food which was incommoding him. From that time up to twelve months ago there was no serious inconvenience, but he was aware of solid food sticking at the lower end of the gullet. He would take fluids and feel it "washed through".

In the twelve months preceding operation there had been much greater obstruction with severe pain until the release into the stomach. A glass of beer would be held up *in toto*, and then felt as a "cold douche" in the stomach. A cup of tea, taken before

FIGURE I.

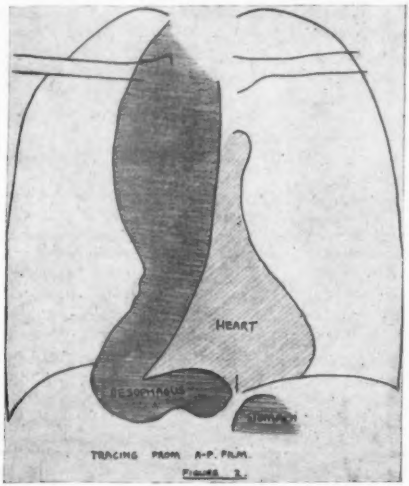

FIGURE II.

the patient lay down at night, caused a sensation of pressure and "asthmatic wheezing" in the breathing until it had passed on. There had been no great loss of weight until an œsophagoscopy two weeks before, which upset him, and he went down seven pounds.

On examination he was still in good condition, though of a nervous, apprehensive disposition. He had claustrophobia amongst other troubles, attributed to experiences in World War I. I witnessed him suffer severe pain around the lower part of the chest and shoulders, while a portion of a meal of tripe taken twenty minutes before passed through the cardia.

Œsophagoscopy revealed gross dilatation, and large quantities of fluid and solid debris which could not be cleared because of repeated blockages of the suction tube. The cardiac orifice was not seen, nor was this expected, as will be judged from Figures I, II and III. (Films by Dr. Bruce Mackenzie.)

The low-lying sigmoid loop of œsophagus was considered a contraindication to conservative treatment and surgical drainage was advised and planned by the abdominal route.

Anæsthesia presented a problem. High spinal anæsthesia, particularly of the continuous variety, to the level of the fourth dorsal segment, would have given excellent relaxation and access, but of itself would not have allowed œsophagoscopy during the

[1] Accepted for publication on August 27, 1945.

operation, nor would it have been safely compatible with temporary palsy of the left side of the diaphragm desired for relaxation of the œsophageal opening. Left phrenic crush was carried out three days before operation, and had spinal anæsthesia been used, there would have been only the three upper intercostal segments and the right side of the diaphragm left for breathing. Finally, the intratracheal use of cyclopropane and oxygen was decided on, and these were given skilfully by Dr. J. S. Hudson, with "Novocain" infiltration (no adrenaline) of the upper recti muscles. The œsophagoscope was passed alongside the intratracheal tube. Had that not been possible, the latter would have been withdrawn and "Pentothal" given intravenously for a period. Saline solution and later blood were given by the intravenous route throughout.

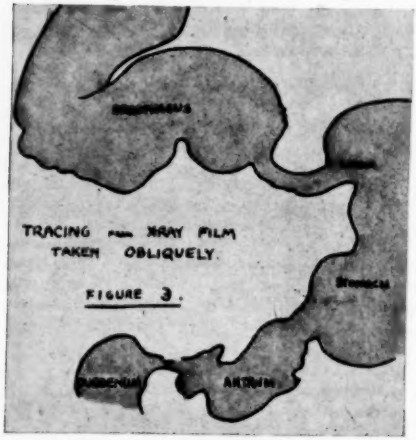

FIGURE III.

The operation was carried out at Green Lane Hospital on May 26, 1945, through an upper left paramedian incision, with later a transverse section of the left rectus muscle. The suspensory ligament of the left lobe of the liver was divided and the lobe retracted to the right. A good view of the cardia was obtained when the stomach was drawn down. The diaphragm on the left side was slack and high. The œsophagus was mobilized and a tape was passed round it. Vessels traversing the front of the cardia were divided and pushed upwards and downwards. Finger dissection of the periœsophageal tissues brought down quite a length of hypertrophied gullet, which was in marked contrast to the narrow segment, about 1·25 centimetres long and 1·25 centimetres wide, adjacent to the stomach.

A cardioplasty was carried out on the lines of a Finney's pyloroplasty (Figure V). First the limbs of the "V" between the œsophagus and the beginning of the greater curve of the stomach were stitched together with intestinal catgut for about an inch. The stomach was incised laterally to this and emptied by suction. When a finger was passed from the stomach through the cardia the sensation of passing the finger through a spastic anal canal was simulated, a band like the subcutaneous part of the external sphincter being palpable at first, but later not so. The incision was carried through the cardia and up into the œsophagus and the beginning of the mucous-and-all-coat-suture begun at the junction, carried up and then down a little along the major gap in front.

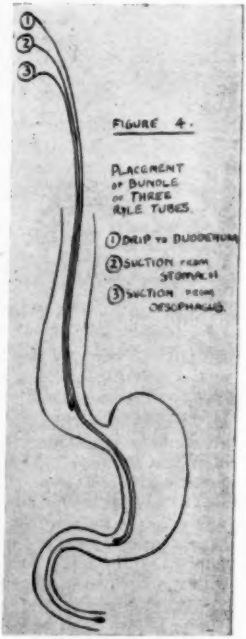

FIGURE IV.

At this point a previously prepared bundle of three Ryle's tubes was put in place. The longest was manœuvred down the stomach and well through the pylorus into the duodenum. The end of the second then lay just proximal to the pylorus. The top end of the bundle (all the tubes being cut off level) was then passed up into the œsophagus past the tape loop and was seen and grasped through the œsophagoscope, which had been introduced shortly before, and through which the gullet had been sucked dry of fluid and debris. The top end of the bundle was finally delivered through the right nostril, the lower end of the third tube of the bundle being seen to lie in the lower part of the gullet (see Figure IV). The anastomosis was then completed in two layers and tabs of omentum were sewn over it above and in front.

A bifid drain, one limb lying near the anastomosis and the other leading to Morison's pouch, was brought out through the wound.

The operation was completed in two and a half hours and the post-operative condition was excellent.

Wangensteen suction apparatus was attached to the œsophageal and to the gastric tubes and glucose and saline solution dripped into the duodenal end. Preparations of amino acids were not obtainable.

Post-operative progress was remarkably smooth in every respect. All three tubes performed their functions and the bundle was removed six and a half days after the operation. Swallowing of fluids and semi-solids was then allowed, and the patient was delighted with the result. He said it was like dropping food "into space". No evidence of leakage from the drain occurred, so it is likely that the anastomosis healed *per primum*. The abdomen remained soft.

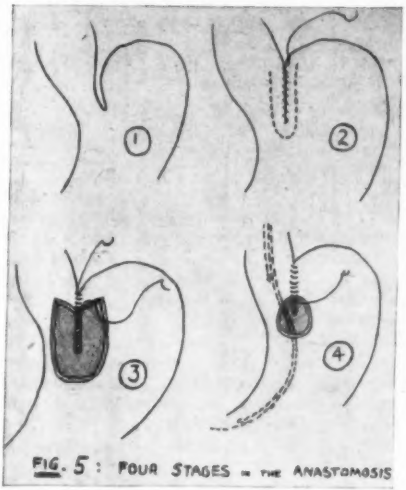

FIGURE V.

Three months later the patient looked and felt well. He had put on fourteen pounds in weight. He had no feeling of obstruction in swallowing, except occasionally when he had eaten quickly. At such a time he would feel the food stick momentarily and then pass on. Radiologically (see Figures VI and VII) Dr. Bruce Mackenzie found there had been some diminution in the size of the gullet, but that there was still gross enlargement in all directions. This finding was paralleled in the case reported by Aickin, Neil, and Robb (1934).

Comments.

This case is of interest chiefly as an example of the gross sigmoid type of dilatation in which conservative measures of dilatation of the cardia were impossible, and even if possible, unlikely to succeed.

Points bearing on ætiology were the intrinsic situation of the stricture, and the sensation of spasm felt on passing the finger into the œsophagus from the stomach. There was no macroscopic infiltration of the tissues around the œsophagus, either above or below the diaphragm. The vagus nerves were not identified. There was no feeling of pressure on the gullet by the edges of the opening in the diaphragm. Indeed these edges were not conspicuous, and certainly nothing more than finger dissection around the gullet was required to deliver a sizable segment out of the thorax. No need for incision of the opening was felt, but of course the left side of the diaphragm had been put out of action.

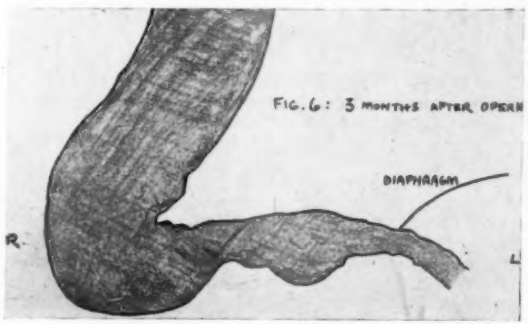

FIGURE VI.

In surprisingly few cases does cardiospasm require surgical relief. Gray and Skinner (1940) note 1,200 cases at the Mayo Clinic, with only seven patients requiring surgery. Mikulicz's manual dilatation of the cardia from the stomach was done four times, œsophagogastrostomy once, thoracocervical sympathectomy once, and abdominal sympathectomy with Mikulicz's dilatation once. In the discussion on this paper Janes, of Toronto, mentioned ten cases in which surgical operation was performed by different Canadian surgeons—six anastomoses and four plastic operations of differing types. Almost no mention is made of the use of the thoracic approach. Walton (1930) described 22 cases of dilatation from below.

There is a voluminous literature on the subject, earlier articles being referred to in a former case report by the author with others (Aickin *et alii*, 1934). Sturtevant (1933) gives an excellent account of the subject in general. Major surgical aspects are fully dealt with by Ochsner and De Bakey (1940 and 1941) and Gray and Skinner (1940).

In the management of such a case as this, requiring surgical drainage, the following points are recommended as helpful:

1. Preliminary cleansing and drainage should be carried out and sulphonamides used throughout.

2. Preliminary left phrenic crush should be performed.

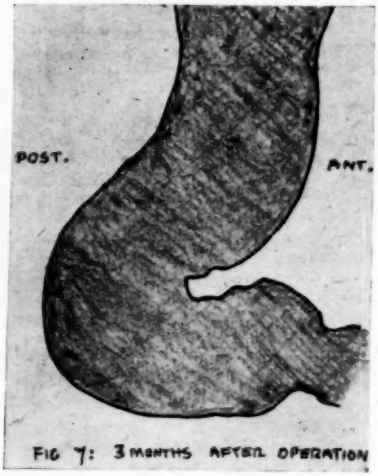

FIGURE VII.

3. Intratracheal anæsthesia should be used with high oxygen content, allowing of quiet breathing.

4. The abdominal approach was found satisfactory and is advised. Nothing substantial supporting the thoracic approach was found in the literature.

5. The triple indwelling tube after operation seemed invaluable.

6. Cardioplasty seemed a much easier and safer procedure than a separate anastomosis in this particular case.

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Surgery in Other Countries.

[In this column will be published short résumés of articles likely to be of practical value from Journals published in other countries and not readily accessible to surgeons in Australia and New Zealand.]

INTRAVENOUS ANÆSTHESIA IN WAR SURGERY.

P. Sabru (Bucharest): *"Die Intravenöse Narkose in der Kriegschirurgie"*, *Der Chirurg*, November 15, 1942.

THE anæsthetic agents of peace-time cannot always be used in war. Spinal anæsthesia must be avoided in the treatment of shocked patients, and inhalation anæsthesia is not suitable for patients with lung and chest injuries, among others, and more especially for those who are gassed. Local and regional methods are theoretically those of the widest application in front-line areas; but they are not greatly in demand, because of the time they consume and of the volume of fluids which would be required in dealing with large numbers of patients. On the other hand, the synthetic barbiturate products, used by the intravenous route, have found a wide field of usefulness.

Sabru has had the opportunity in war of testing the efficiency of one of these, "Eunarcon",[1] which he had previously used largely in peace, and has found it of constantly widening usefulness. The technique of its use has the great advantage in war surgery that only minimal preparation of the patient is necessary and wounded men can be anæsthetized immediately on admission to the hospital—even on the stretcher if necessary. Depth of narcosis is controlled by fractional doses during the operation, and diffusion of the fluid outside the vein produces no ill effects.

The patient lying on the operating table, and the surgeon being ready to commence the operation, the injection is commenced; generally in one of the cubital veins, but sometimes of necessity in a vein of the lower extremity. Two to three cubic centimetres are injected at the rate of one cubic centimetre in thirty seconds, and a pause of one and a half minutes is allowed for these to take effect. The patient generally falls asleep at this stage, and there may be a short period of apnœa and some slight jerking of the limbs; both of these are indications that the injection has been made rather too quickly and need cause no other concern, but it is necessary to wait till they have passed before the injection is continued. An additional two cubic centimetres are then given at the same rate as before, following which full narcosis and muscular relaxation should be attained. Corneal and tendon reflexes are abolished, and the jaw falls. The pupils are dilated and remain so throughout the operation. The pulse weakens and the blood pressure shows a slight fall. This is the moment for commencing the operation.

Sometimes young, robust patients do not sleep after even five cubic centimetres, and patience on the part of both surgeon and anæsthetist is required. Anæsthesia will come after a further one to three cubic centimetres have been given. The anæsthetist then stands by, ready to inject further quantities should anæsthesia show signs of passing off. How much should be given is a matter for individual judgement in each case. An experienced anæsthetist will judge the amount intuitively, as he does with ether. In general, however, it may be said that eight to ten cubic centimetres of "Eunarcon" will give an anæsthesia lasting from fifteen to twenty minutes. In one case, in which the operation lasted for an hour, 40 cubic centimetres were given without ill-effect to the patient. The period of awakening with "Eunarcon" is especially peaceful when compared with that following the other barbiturates, and the close watching necessary with these is not needed when "Eunarcon" is used. Waking is slow, occurring seldom in less than an hour, but it is always quiet and peaceful. For short procedures this quality of "Eunarcon" is perhaps something of a drawback, but wakening is accompanied by complete retrograde amnesia, and only occasionally is headache or dizziness noticed.

From Sabru's experience, the following types of condition are specially suitable for "Eunarcon" anæsthesia: (i) All explorations of wounds, including their excision and the removal of foreign bodies. Intravenous narcosis in these cases permits of double the number of wounded being dealt with. (ii) Amputations and similar swiftly finished procedures. (iii) Bone surgery of all sorts, especially fractures in which

[1] "Eunarcon" is the sodium salt of isopropyl-N-methyl-β-bromethylbarbituric acid. It is put up in ampoules containing five or ten cubic centimetres of the 10% solution.

movements and pre-anæsthetic excitement must be avoided. (iv) Thoracic and lung surgery, in 90% of which cases the intravenous is the only convenient method. In these cases "Eunarcon" is tolerated exceptionally well. (v) Neck, jaw and face injuries. (vi) Abdominal surgery. Sabru states that muscular relaxation is good. (vii) Multiple wounds or large area burns in patients who are gassed. (viii) The changing of painful and adherent dressings. A short anæsthesia of five to ten minutes can be achieved with four to five cubic centimetres of the drug, and this amount may be injected daily without ill effect.

The contraindications appear to be infections of severe grade of the lung, liver or kidneys. Anæmia, even of severe degree, does not militate against the safe administration of "Eunarcon".

ARTHUR E. BROWN.

CIRCULATORY DANGERS DUE TO THE TOURNIQUET.

H. Schwiegk: *"Die Gefahren der Esmarch'schen Blutleere für den Kreislauf", Zentralblatt für Chirurgie,* Volume lxx, 1943, page 1614.

THE possibility of throttling the arterial supply of a limb by the use of a tourniquet and thereby producing hæmostasis is so simply achieved and so widely put into practice that its dangers are often forgotten. It is known that after a period exceeding two hours such hæmostasis can produce in the limb concerned paralysis, ischæmic contracture, thrombosis and gangrene. It has been less well known that the release of such a tourniquet is liable to cause serious changes in the general circulation. Such phenomena were observed in the first World War, but were attributed to the injury rather than to the tourniquet.

A series of animal experiments into these changes were undertaken by Schwiegk and Schöttler. On the application of a tourniquet to both hind legs of a dog there followed an immediate rise in blood pressure of 10 to 30 millimetres of mercury and the pressure returned to the normal level in an hour. But, if the tourniquet was kept in place for five hours or more, its removal was followed by an immediate fall in the general blood pressure of 30 to 50 millimetres, and this drop was followed in all experiments after the lapse of three to seven hours by an increasing circulatory collapse, terminating in the death of the animal. Locally there was seen a massive œdema in the previously constricted limb. The œdema fluid had an albumin content equal to that of the plasma, while the blood erythrocytes and the blood hæmoglobin content rose steadily until the hæmoglobin value reached 150% or 170% of normal. These changes can be explained only by supposing an increased permeability to albumin in the capillaries of the constricted limb. The amount of plasma so lost to the circulation can be estimated at 30% to 40% of the total blood volume. A similar loss of 40% to 60% of blood volume following an accident leads to death. What further effect the depressor substances liberated from the injured limb have may be left open for the moment. It is found that the collapse produced by the experiment can be countered by an infusion of serum, which for this purpose is more suitable than whole blood.

The longer the tourniquet has been left on, the quicker and the more certain is a fatal ending. If the tourniquet is in place for less than five hours the result is rarely fatal. Another varying factor in producing collapse is the mass of body tissue occluded from circulation. Constriction of one fore limb causes no lasting fall in blood pressure; occlusion of one hind limb only rarely ends fatally; but occlusion of both hind limbs causes fatal circulatory collapse with regularity. If the compressed limb is amputated before the tourniquet is released, no sign of circulatory collapse is seen.

The view that it is oxygen lack which causes this increased capillary permeability is supported by two further observations. Oxygen lack increases with increased metabolism in the compressed limb. If this limb is warmed while the tourniquet is in place, fatal collapse follows its removal within two hours, whereas if it is cooled the tourniquet may be left in place for up to nine hours without ill effects on its removal.

These experiments and their interpretation may be summarized as follows. Serious general circulatory failures will follow the release of a tourniquet too long applied, and these are primarily referable to a plasma outflow from the circulation. The longer the period of application of the tourniquet, the larger the mass of body tissue occluded; and the warmer the tissue is kept, the swifter and more severe are the circulatory results.

There is no reason to suppose that similar reactions do not occur in man. Clinical observations of such happenings have recently been published with an increasing frequency and will probably be still more frequent when such collapse is properly

attributed to the tourniquet rather than to the original injury or loss of blood. The practical considerations from these experimental observations are:

1. The tourniquet is not a harmless piece of apparatus, and after its removal close watch must be kept on the patient for the ensuing twelve hours, with transfusion ready for early use at the first sign of circulatory depression.

2. How long a tourniquet may be safely left in place in man has not yet been proved, but it is probably less than the five hours allowed in the case of dogs.

3. A tourniquet left on too long may be regarded as a possible indication for amputation, which is curative.

4. While the tourniquet is in place, cooling of the limb is essential.

5. Local damage (contractures, paralysis or gangrene) is to be feared equally with general circulatory depression, even after the latter has been successfully countered. The danger of these is also lessened by cooling the limb.

6. The use of a tourniquet must be regarded as a life-saving measure only when attempts to control the bleeding locally have failed, and its special dangers must be recognized when a long transport journey is in prospect.

7. More clinical experiences of this phenomenon should be published.

ARTHUR E. BROWN.

WOUND NEURITIS.

F. Heck (Würzburg): *"Ein weiterer Beitrag zur Schussneuritis"*, *Zentralblatt für Chirurgie*, November 20, 1943, page 1681.

HECK reports in this paper eleven cases of very severe pain in one or other limb resulting from war injury, and also one case of particular severity dating from a wound received in 1918. In all cases the diagnosis of wound neuritis was established beyond all doubt by neurologists. The pain was intolerable in intensity, more than one patient expressing a desire to commit suicide. The limbs gave indications of nerve damage, for the most part in the form of blue coloration, wasting, desquamation and increased sweating, along with fibrillation of the nails. Radiographically the bones of the extremities showed appearances closely resembling those seen in the acute bone dystrophies of peace-time.

The case which is recorded as dating from the previous war is worth reporting, as it indicates the very distressing nature of this complaint.

The man was wounded by a shell splinter in the inner side of the upper part of the left arm in March, 1918, and the fragment was removed in May. A few weeks after being wounded, the patient experienced a severe burning pain in the left hand. In December, 1922, a neurolysis was performed and a neuroma removed. Relief from this operation lasted only two days. During 1923 the patient relied on various drugs, including morphine, for comfort, but in May, 1924, a further neurolysis was undertaken and a neuroma of the median nerve was excised. Pain recurred in a day or two, and in the next month, June, 1924, another operation was performed and a fresh neuroma was removed from the median nerve. Two hours after this procedure the patient complained that the pain was unaltered. Various injection methods left him unrelieved, and in November, 1924, a brachial periarterial sympathectomy was performed, during which the artery had to be ligated on account of hæmorrhage. There was relief of pain following this, but it returned, and at the patient's request his arm was amputated eight days after the sympathectomy. Relief following the amputation lasted only fourteen days; and in August, 1925, he underwent his seventh operation, an extirpation of the brachial plexus. This also failed to bring relief, and during the next fifteen years he became a morphine addict, with no further surgical attempts to relieve him until in 1941 injection of the stellate ganglion with three cubic centimetres of alcohol brought full relief for the first time since he was wounded. It did not persist for long, however, and early in 1942 he sought further help, and the resection of his stellate ganglion was advised, but was not carried out owing to Heck's departure for army service.

In most cases the more simple methods of treatment should be given a trial before surgical measures are planned. Heck succeeded in giving relief in two mild cases by means of injections of acetylcholine together with vitamin B_1, although he has never had any success with the vitamin alone. He had previously expressed the opinion that periarterial sympathectomy would bring results, but in the light of the present series he has abandoned that hope, and he now rates that method as low, in spite of its superior ease of performance, on account of its very frequent failures. He believes now that the only sure means of giving relief in these distressing cases is by a direct attack on the sympathetic ganglia. In the upper limb this means the removal of the stellate ganglion; in the lower limb, removal of the lumbar sympathetic chain.

In removing the stellate ganglion the posterior approach is preferred to the anterior route as advocated by Leriche; and he uses the technique described by Rieder in *Der Chirurg* in 1943. The incision is made two fingers' breadth from the spinous processes, and the muscle is cut through till the ribs are exposed. The posterior four centimetres of the first four ribs are removed, including the heads of the ribs, and the corresponding transverse processes are also excised, so as to render the lateral surfaces of the vertebral bodies visible. The sympathetic rami are easily seen somewhat median to the heads of the ribs, the pleura and intercostal nerves being guarded. For the lumbar chain Heck prefers Royle's extraperitoneal approach.

In deciding which ganglia should be removed for the relief of pain in each individual case Heck regards Rieder's schema of the regional distribution of the sympathetic fibres as a useful guide. For radial pain the middle and inferior cervical ganglia, and for median and ulnar pain the inferior cervical and the upper two thoracic ganglia may be excised. In the lower limb the fourth and fifth lumbar ganglia with the first and second sacral, should, according to this schema, be removed. Heck, however, has come to disregard this supposed distribution, and excises simply the stellate ganglion in upper limb cases and the second, third and fourth lumbar ganglia in those of the lower limb. In all his cases this has led to permanent relief. Santas removes only the first lumbar ganglion in lower limb cases; and similarly, in attempts to relieve the pain of *angina pectoris*, Brown and Coffey, by simply removing the superior cervical ganglion and cutting through the sympathetic chain, achieved successes as satisfactory as those of Jonnescu, who removed the three cervical ganglia *plus* the first thoracic ganglion. It is apparently sufficient to break the great sympathetic reflex paths at a suitable spot to obtain the desired result.

In regard to infiltration of the ganglion with alcohol, Heck has come to a conclusion directly opposite to that of Kirschner and his pupil Philippides. The latter has expressed the view that the results of alcohol injection are so good that it will render the operation of resection obsolete. Heck has followed the technique of Philippides very accurately and has not seen any lasting success. In his cases he achieved the signs which indicate successful infiltration of the ganglion—circulatory changes, temperature rise and so on—and the temporary relief of pain was immediate, but it always recurred in a few hours. Repeated infiltrations were no more successful, and Heck has always had to fall back on resection of the ganglion. Test infiltrations of the ganglia with "Novocain" for the purpose of estimating what may be expected from the excision are extremely useful; but for lasting results they are no more valuable than is periarterial sympathectomy.

ARTHUR E. BROWN.

Reviews.

The Sick African. By M. GELFAND, M.B., Ch.B., M.R.C.P., with a Foreword by COLONEL A. P. MARTIN, O.B.E., M.D., D.P.H., D.T.M. and H.; 1944. Capetown: Stewart Printing Company (Pty.) Limited. $8\frac{3}{4}'' \times 5\frac{1}{2}''$, pp. 373, with 123 illustrations. Price: 25s.

THIS appears to be an excellent book for the purpose for which it was conceived. It is not an exhaustive treatise, with all the detail intended for the beginner and utterly ignorant, but is a post-graduate aid in what in many ways is a special subsection of general medicine. Most of what might be regarded as somewhat irregular or even as shortcomings in its make-up is readily explained on this basis. The sequence of the chapters does not follow the usual scheme, but the ease with which any of them can be referred to neutralizes any sensitiveness on that score.

The conciseness of the descriptions of the various diseases, particularly in a few cases, might be considered to err by being overdone; but on the other hand the selection of the outstanding features is essentially what is wanted by the post-graduate, to the exclusion of the padding of unimportant detail. The same applies to the consideration of the pathology, which has been touched upon rather than given a lengthy description, and this again is an advantage for the man in practice.

The grouping of the pictures, mostly away from the text, might also be criticized as being less handy and effective, but the art paper used for them, with the resulting increased excellence of their production, more than compensates for this disadvantage.

Some adverse criticism might be aimed at the relative lack of surgical pathology and its treatment, but here also this is completely offset by the fact that the vast majority of the diseases are medical, especially among natives, and surgery plays a more or less minor role.

Dr. Gelfand is to be congratulated on supplying a real and genuine help to those dealing with natives, and, as a competent physician and pathologist, in presenting a clear and concise description of the important features of the diseases considered. We have no hesitation in recommending the book with the greatest confidence to all who may be interested.

Endocrine Man: A Study in the Surgery of Sex. By L. R. BROSTER, O.B.E., F.R.C.S., with a Foreword by SIR PETER CHALMERS BITCHELL, C.B.E., D.Sc., F.R.S.; 1944. London: William Heinemann Medical Books Limited. 8½″ × 5½″, pp. 155. Price: 12s. 6d.

THE author of this little book is well known for his studies on virilism and the suprarenal gland. These are elaborated in his larger work on "The Adrenal Cortex and Inter-Sexuality", written with a number of collaborators. The present work is apparently compiled for the more general or lay reader, care being taken to define the meaning of words, such as cephalic and caudal, and of expressions, such as symbiosis. The part played by hormones, and particularly those of the adrenal cortex, in relation to the primitive instincts of growth, self-preservation and reproduction, is discussed in detail. Dr. Broster would apparently allot the same part to the adrenal cortex in ante-natal life as is ascribed to the hypophysis later, namely, leadership of the endocrine orchestra, and he reminds us that even in such a primary consideration as sex determination the chromosomes may not alone be responsible. There is a great deal of interest in this book, both for the medical reader and the general reader interested in biology. It is thought-provoking and, if rather ambitious, it has its lighter touches in the introductory quotations to its chapters and in the allusions to mythology and the classics to be found scattered throughout the text. Sir Peter Chalmers Bitchell writes a commendatory foreword.

Journal of Neurosurgery, Volume I, Number 1, January, 1944. Edited by LOUISE EISENHARDT. Springfield, Illinois: Charles C. Thomas. 10¼″ × 7″, pp. 81, with illustrations. Price: $1.25, single copy; $8.00, quarterly.

IT is a pleasure to record the appearance of the first journal in the English language devoted to neurosurgery and to note that it has been founded by the Harvey Cushing Society. The members of the journal's editorial and advisory boards are drawn from the leading neurosurgeons of the Americas, Canada, the British Isles and Sweden. Later, a wider representation is envisaged so as to embrace all lands where neurosurgery flourishes.

The need for a journal such as this has been evident for a long time. It became acute when, in 1939, the *Zentralblatt für Neurochirurgie*, established in 1936, was no longer available.

The journal opens with an article by Horrax on the late Harvey Cushing's contributions to neurological surgery. Next comes a paper by Franc Ingraham and Orville T. Bailey on "The Use of Products Prepared from Human Fibrin and Human Thrombin in Neuro Surgery". This is likely to be epoch-making, for almost certainly it marks a milestone in neurosurgical progress. New methods are detailed for controlling troublesome and serious intracranial hæmorrhage during operation and for preparing a suitable substitute for normal human *dura mater* by the use of fibrin foam and fibrin film respectively.

The remainder of the well-printed and beautifully illustrated pages, which run in all to eighty-one in number, covers important aspects of current clinical and practical neurosurgery. An important place is given to experimental research in intracranial phenomena.

The journal covers admirably the scope of neurosurgery and will become a surgical publication of the first importance.

Textbook of Medicine. By J. J. CONYBEARE, M.C., D.M. (Oxon), F.R.C.P.; Seventh Edition; 1945. Edinburgh: E. and S. Livingstone. 8½″ × 5¼″, pp. 1184. Price: 30s.

"TEXTBOOK OF MEDICINE", edited by J. J. Conybeare, physician to Guy's Hospital, London, has reached its seventh edition. Since a standard textbook of medicine has some interest to surgeons as a work of reference, this book is briefly reviewed.

The excellence of this standard textbook in medicine is well known. In this edition there is a new section on sulphonamides; the section on pulmonary tuberculosis has been rewritten; also there are new articles on bronchiectasis and bronchial neoplasms, and there is an article on sarcoidosis.

The article on constrictive pericarditis has an interest to surgeons. The articles on sinus thrombosis, acute and subacute myelitis, and epilepsy have been rewritten by Dr. F. M. R. Walshe.

This up-to-date textbook of medicine is one which might very well grace the library shelves of every surgeon as a work of reference.

Essentials of Local Anæsthesia in Dentistry. By A. C. BOWDEN, H.D.D. (Edin.), L.D.S. (London); 1945. Bristol: John Wright and Sons, Limited. 7¼″ × 4¾″, pp. 60, with illustrations. Price: 6s.

"ESSENTIALS OF LOCAL ANÆSTHESIA IN DENTISTRY" is a small book which has been written for the use of dental students. It is an outline of the subject and deals with the choice of anæsthetic agents, the instruments used, drugs and solutions, premedication, and the anatomy concerned in nerve blocking. The author is senior dental surgeon at the Birmingham General Dispensary.

Extensile Exposure Applied to Limb Surgery. By A. K. HENRY, M.B. (Dublin), F.R.C.S.I.; 1945. Edinburgh: E. and S. Livingstone. 9¾″ × 6¾″; pp. 180, with 127 illustrations. Price: 30s.

IT is axiomatic that a knowledge of anatomy is the basis of operative surgery. The surgeon, however, requires a broader and more comprehensive view of structure than is commonly acquired in his undergraduate days. He starts with laborious detail; but eventually, and often suddenly, the general principles upon which the region is constructed are revealed and a new sense of comprehension is awakened. It is this sense of anatomical comprehension which Mr. Henry sets out to arouse. He demonstrates how the principles of anatomy may in the limbs be used to design surgical exposures which may be drastically extended without danger to important structures. Indeed, some of the possibilities are astonishing, and the whole book will be followed by the surgeon with the greatest interest.

Mr. Henry writes in a free, racy style, replete with allusion and metaphor. This makes for pleasant reading, but, at times, leads to a lack of clarity. For example, it is difficult to visualize exactly what action is attributed to the *musculus gluteus maximus*. We read: "I think it therefore possible that maximus may work instead like a supporting giant—a kind of Atlas—bearing the body's weight on fleshy hands while quadriceps, relieved of strain, procures the movement up and forward of a mass maintained at every stage in levitation." There is some advantage in technical language for a technical subject.

No account of this book would be complete without reference to the numerous and beautifully clear illustrations and to the general excellence of its production. The book brings an original and refreshing point of view to the subject of limb surgery, and is well worth consultation before any unusual or difficult operation on the arm or leg is undertaken.

Medical Jurisprudence and Toxicology. By JOHN GLAISTER, J.P., D.Sc., M.D., F.R.S. (Edinburgh); Eighth Edition; 1945. Edinburgh: E. and S. Livingstone. 8¼″ × 5¼″; pp. 704, with 220 illustrations. Price: 30s.

THE eighth edition of Glaister's "Medical Jurisprudence and Toxicology" reaches the same high standard of previous editions. This book is deservedly popular, and great praise is due to the author and publisher for the high quality of this publication, especially in the face of many war-time difficulties.

There have been many additions to the text, the setting out of which has also been altered to some extent. Many new illustrations have been included and a large number of these, including photomicrographs, are in natural colour. These are particularly valuable, especially in the chapters on head injuries and on the examination of blood stains.

New material has been added in relation to legal procedure and medical acts as they apply in Scotland and England. Although there are many differences in Australia in these respects, readers will find much of interest in their perusal. As in previous editions, identification is completely covered, and the Ruxton case is supplemented by a short description of the Dobkin case and two other cases concerning portions of human remains. Gordon's conception for the classification of deaths of medico-legal importance is incorporated in the chapter on asphyxia, but workers in the field of forensic medicine, and apparently the author, are not willing or likely to abandon the term asphyxia. The author regards frostbite, immersion feet and trench feet as

synonymous for all practical purposes, and in his description of these gives Ungley's opinion, which was formed in an extensive study of the subject.

New material has been added to the subject of wounds, including a short paragraph on the crush syndrome. We should have appreciated the inclusion of blast injury in this chapter rather than at the end of the book under war injuries.

The chapter on examination of the blood has been rewritten to some extent and now includes a paragraph on the Rh factor, the M and N factors and agglutinogens in the saliva. New material appears on the subject of strangulation. The conclusions of Denny-Brown and Russell on the causation and mechanism of concussion are an interesting addition to the subject of fracture of the skull. In the section on toxicology the inclusion of short descriptions of poisoning by toxic substances used in industry and the toxic effects of the sulphonamides is welcome in the light of modern experience.

In compiling the seventh edition the author decided to omit methods of quantitative analyses as rightly belonging to the province of the analytical chemist. He has largely followed this in the eighth edition, with the exception of detailed descriptions of methods of alcohol estimation in body fluids and tissues.

Many new illustrative cases have been added, including some of great medico-legal importance. In a book of this type case records are of great value to the practitioner and student. Amongst publications on medical jurisprudence and toxicology this textbook must take its place in the highest rank.

A Textbook of Surgery. By JOHN HOMANS, M.D.; Sixth Edition; 1945. Springfield, Illinois: Charles C. Thomas. 9¼″ × 6″; pp. 1286, with 530 illustrations. Price: $18.00.

THERE is no need to give a lengthy review of this excellent textbook, which has previously received appreciation in these columns. The revised edition maintains the high standard of its predecessors.

It is indeed refreshing to note the author's attempt to foster the student's interest in surgical history, as each chapter opens with an excellent *précis* of landmarks of the surgery of the subject in question and deals with the men whose efforts have provoked our knowledge in regard to it. Another pleasing and valuable feature is the short description of the anatomy and physiology relevant to the surgery of the region or organs under discussion in each chapter.

Being, as it is, the product of a famous medical school, this book is full of sound surgical opinions which are beyond criticism. It is doubtful, having regard to the author's intention of its purpose, if there is a better textbook of surgery in the English language.

A Handbook of Roentgen Diagnosis of the Osseous System. By VINCENT W. ARCHER, M.D.; 1945. Chicago: The Year Book Publishers, Incorporated. 8″ × 5½″; pp. 320, with 148 illustrations. Price: $5.50.

AMERICAN radiological monographs are generally of a high standard, and the author of this "Handbook of Roentgen Diagnosis of the Osseous System" has well maintained the good repute. The compact volume of 320 pages is by Vincent Archer, Professor of Roentgenology in the University of Virginia Medical School, and he is obviously a teacher of wide experience, both radiological and clinical. While it is desirable, because of the complexities of modern X-ray technique and the abounding pitfalls in radiodiagnosis, that such investigations should be carried out by a competent radiologist, this is not always feasible, and the book has been written primarily for those who, without the background of special training, have on occasions to carry out their own technical and diagnostic X-ray work. The text explains there are relatively few simple radiological examinations, and in the description of the normal and abnormal bony shadows emphasis has been placed on the innumerable traps that await the unwary.

The author most properly writes of the unwisdom of making any but the most provisional interpretations from wet films. A regrettable practice has developed in hospitals (perhaps as a result of war's exigencies) of some clinicians demanding wet films to be sent to the out-patient clinics, at times even before the radiographer has completed their photographic processing. The demerits of this impatient practice would appear far to outweigh any unproven time-saving.

The author is also condemnatory of those who would employ fluoroscopy alone to make a diagnosis of fracture, particularly when, as is so often the case, the eyes of the uncertain diagnostician are quite unaccommodated; this is rushed X-ray work in a most baneful guise, and fortunately nowadays is seldom practised except by uninformed and meddlesome resident medical officers.

The sections—all full of most useful information—deal with technique and principles of interpretation, injuries to the skeletal system other than the spine, the vertebral column, bone diseases and abnormalities of childhood, bone diseases occurring principally in adult life.

The format of this book, like all produced by the Year Book Publishers of Chicago, is beyond cavil, and the illustrations—almost 150—have been well chosen and reproduced; the index is comprehensive; and this thoroughly sound monograph can be warmly recommended to medical student, general practitioner and surgeon.

A Handbook of Diagnosis and Treatment of Venereal Diseases. By A. E. W. McLACHLAN, M.B., Ch.B. (Edinburgh), D.P.H., F.R.S. (Edinburgh); Second Edition; 1945. Edinburgh: E. and S. Livingstone. 7¼" × 4¾"; pp. 379, with 159 illustrations. Price: 15s.

THE author is a man of wide experience as a surgeon, as a director of a centre for the treatment of venereal diseases, and as a lecturer to both students and to post-graduates. As such he is qualified admirably to attempt this book. As a member of the editorial committee of *The British Journal of Venereal Diseases*, he has obviously taken from this training and exploited the technical knowledge gained during his editorial years.

The result is a handbook which is really a handbook, in which the path of the reader is made delightfully easy by the judicious use of heavy type just where it should be used. The prose is simple, the order logical, the type good and the illustrations profuse and pertinent.

In the section devoted to syphilis, the introduction and the description of the early and late manifestations are put clearly and concisely. The methods of diagnosis are described carefully from both the clinical and laboratory angles, and one cannot criticize the result. Further chapters describe the progressive stages adequately and with sufficient illustrations. The spread devoted to the table of differential diagnosis of genital lesions is particularly sound and complete. When one reaches the chapters devoted to the actual treatment of syphilis it seems that the space occupied by the "Concurrent Intermittent Therapy", which "is almost universally employed in this country", is unjustifiably larger than the space devoted to the almost casual dismissal of the "Alternating Continuous Treatment", which has been adopted generally by the services in Australia over the war years.

The close description of the many therapeutic agents is extremely helpful, and the toxic sequelæ of metallic therapy are dealt with concisely and well. Many practitioners would be interested in a more clearly defined scheme of the actual duration of treatment, and would prefer to adhere to some dogmatic scheme rather than to depend upon their own judgement. Some scheme along the lines of E. T. Burke's "Efficiency Index of Treatment" might have been evolved. It is unfortunate that here, as in the pages devoted to the treatment of gonorrhœa, the work was written in the very early days of penicillin, before any considered evaluation of this newest treatment could be made.

In the portion devoted to gonorrhœa there is little at which to cavil. The imperative necessity of the early recognition of the first stage of urethral stricture by routine urethroscopic examination is stressed very satisfactorily, and the assessment of the value of the complement deviation test is in accord with recent opinion.

In all, Dr. McLachlan has produced a handbook which could well become a standard textbook for the student. It will be invaluable to the practitioner who "maintains a constantly high index of suspicion as to the possible occurrence of a venereal disease".

Endocrinology of Woman. By E. C. HAMBLEN, B.S., M.D., F.A.C.S.; Second Edition; 1945. Springfield, Illinois: Charles C. Thomas. 9¾" × 6⅝"; pp. 592, with 157 illustrations. Price: $8.00.

THIS book aims at the clinical application of endocrine physiology to diseases of women, and is a complete review of pre-war literature of the endocrinology of the ductless glands, the chemical constitution of the secretions of the ductless glands, their clinical action, and the histological changes that they bring about both naturally and when administered clinically.

The normal menstrual, gestational and climacteric changes that occur in the organs of woman are fully described. Methods of examination and the trays required to be set up for the examinations are shown both diagrammatically and by verbal description. A full chapter deals with bacteriological and histological methods of examination, particular emphasis being laid on the interpretation of endometrial biopsies. Meticulous and complete methods of history-taking and examination are described. It is hard to

imagine how such complete methods oculd be adopted as a routine. The author describes the "frog" or "xenopus lævis" test for pregnancy, which apparently is just as accurate as the Aschheim-Zendok and Friedman tests (that is, 98% to 99% of accuracy). In this test the frog is injected with "pregnant urine" and the result of the test is regarded as positive if excretion of eggs occurs within eighteen hours. These particular frogs ovulate only after mating or the injection of hormones, and can be kept and used again and again at four-weekly intervals. The author states that this test should supplant all others, since it is cheap, quick, and requires no particular skill in performance.

Important chapters describe the management of a patient with sterility, great stress being placed on the value of utero-salpingography in diagnosis, and of a complete examination of the male partner. In order that the public should be educated into what constitutes a satisfactory examination in cases of sterility, the patient is recommended to read another book by Hamblen—"Facts for Childless Couples".

Discussing the treatment by endocrine glands of husbands in sterile marriages, the author points out that hypothyreoidism is encountered in approximately 16% to 20% of cases. He attributes 5% of the pregnancies which occur in childless couples after treatment to thyreoid therapy given to the husband. He considers that endocrine therapy or vitamin *E* therapy for sterility on the part of the male is not helpful. In treatment of a sterile wife thyreoid therapy was used and hypothyreoidism was found in 25% of wives. An ovulatory failure was found in 15%, due in half the cases to hypothyreoidism. The author advises "cyclic steroid therapy" in some cases. This restores a fertile uterine bleeding and rhythm in 50% of cases.

Functional dysmenorrhœa is considered to be due to essentially normal uterine contractions which reach conscious levels because of lowered pain thresholds. The author mentions "nasal dysmenorrhœa" which is relieved by cocainization of the "genital spot" which is located on the anterior turbinate. If this brings about cessation of the dysmenorrhœa subsequently crystals of trichloracetic acid or actual heat may permanently anæsthetize the area. The author considers that the endocrine therapy of dysmenorrhœa is disappointing, but that diathylstilbœstrol (one milligramme daily for the first ten post-menstrual days) often helps.

This book, being both practical and conservative in outlook, consolidates much of the ground already won in the vast and rapidly expanding field of endocrinology of woman.

Cleft Palate and Speech. By MURIEL E. MORLEY, B.Sc., F.C.S.T.; 1945. Edinburgh: E. and S. Livingstone. 7½″ × 4¾″; pp. 172, with 52 illustrations. Price: 7s. 6d.

THE author of this small book has been for several years speech therapist working in association with W. E. M. Wardill at Newcastle-upon-Tyne. She has succeeded in epitomizing most of the modern thought and practice in relation to palate surgery. There is a concise and complete description of the anatomy and physiology of the palate, with more detailed discussion of the physiology of speech. The chapter on the surgery of cleft palate is very properly influenced by the thought of Wardill and is quite sound. The difficult subject of speech therapy and training is dealt with in some detail. Each chapter is freely illustrated and there are many well-drawn colour prints. Detailed notes of case histories illustrate in a practical way the objects of the speech training *régime*, and the many and varied problems to be overcome.

This book should be of great value to all surgeons and physiotherapists who are called upon to deal with these cases.

Fractures and Orthopædic Surgery for Nurses and Masseuses. By ARTHUR NAYLOR, Ch.M., M.B., M.Sc., F.R.C.S. (England and Edinburgh); 1945. Edinburgh: E. and S. Livingstone. 8½″ × 5¼″; pp. 300, with 243 illustrations. Price: 16s.

THIS book is a clear, dogmatic synopsis of orthopædic surgery, set out in a way that will make it as interesting to the medical practitioner as to the nurse, if not more interesting. It is profusely illustrated by photographs and many clear drawings of fractures and their deformities. No medical student will find a better exposition of fractures in general than in this book, where the various types of fractures—longitudinal, transverse, oblique, spiral, comminuted, impacted *et cetera*—are described and illustrated by simple line drawings on the same page. The book is modern to the minute, including detailed instructions for the use of the Bunyan-Stannard irrigation for compound fractures; illustrations of the mechanism of backache and sciatica due to prolapse of the intervertebral disk; and a description of the instruments used for insertion of the Smith-Petersen nail and of the operation itself. The nurse before her examination will find a whole chapter given over to orthopædic apparatus and instru-

ments and photographs illustrating them. In addition she is given a list of instruments required for any particular one of the various orthopædic operative procedures.

Of interest is the mention of traumatic arterial spasm, said to be due to afferent impulses originating from the injured segment of the artery and reflexly producing spasm of the whole artery and of the vessels of its collateral circulation. Treatment suggested is by arteriectomy, sympathectomy and paravertebral ganglionectomy. The modern treatment of keeping the limb cooled in ice to reduce its metabolism and at the same time of warming the remainder of the body to produce reflex vasodilatation of the affected limb is described.

The little book is to be most highly recommended to doctors, students and nurses alike. It is certain to find a secure position for itself in medical literature.

The 1944 Year Book of Industrial and Orthopedic Surgery. Edited by CHARLES F. PAINTER, M.D.; 1944. Chicago: The Year Book Publishers. 7″ × 4½″; pp. 432, with 282 illustrations. Price: 23s. 6d.

No orthopædic surgeon can afford to miss this excellent publication. It provides a concise account of current orthopædic literature and illustrates how the trend of authors is away from tuberculosis, congenital defects, rhachitic deformities and flat-foot. It is good to see chronic arthritis figuring more frequently in original articles. Palindromic and psychogenic rheumatism are new concepts mentioned. Among the wide range of articles covered are found concise accounts of bone changes in leprosy, aluminium acetate for *osteitis fibrosa*, Sudeck's atrophy, internal paracentesis for bursitis, Sister Kenny's treatment, grease-gun injuries, and so on.

The Year Book shows that fracture literature is unfortunately dominated by accounts of internal and external metallic fixation. The X-ray films are in general well reproduced. In the industrial section reference is made to a series of 450 routine X-ray examinations of the lumbar section of the spine carried out before the subjects commenced heavy work. No less than 80% showed some pathological condition without having any backache whatever.

Classic Descriptions of Disease. By RALPH H. MAJOR, M.D.; Third Edition; 1945. Springfield, Illinois: Charles C. Thomas. 9¼″ × 6¼″; pp. 679, with 158 illustrations. Price: $6.50.

THE appearance of the third edition of Major's "Classic Descriptions of Disease" is noted with pleasure. This book, which has itself become a classic, first appeared in 1932 and rapidly gained a well-deserved popularity. Its great value lies in the fact that it is the only book which contains so many of the classical descriptions translated from their parent language into English. The author is to be complimented not only for his selection of material and illustrations, but also for his masterly translations. In this edition Dr. Major has added further material and an extensive bibliography, which enhance an already great book.

This is a book which can be thoroughly recommended to all those surgeons and physicians who have not made its acquaintance.

Notes and Comments.

AT a recent meeting of the Royal Australasian College of Surgeons, when a paper was given by Surgeon-Captain Lambert Rogers, R.N.V.R., on cranial injuries, the view was expressed that the education of both students and surgeons was hampered by lack of autopsy demonstration in these cases.

Representations have been made in the past that this deficiency should be rectified by some arrangement under which students at the teaching hospitals might be enabled to see autopsies conducted by the hospital pathologists in cases of fatal head injury, but so far without result.

It is understood that, under the *Coroners Act*, 1928 (Victoria), the coroner has certain powers of delegation of authority. If, under these powers, the pathologists of the teaching hospitals were enabled to conduct autopsies in selected cases of death from head injuries, some real progress in surgical education would undoubtedly result.

BALCOMBE QUICK.